COMMONWEALTH OF VIRGINIA
STATE WATER CONTROL BOARD

9 VAC 25-790
SEWAGE COLLECTION AND TREATMENT REGULATIONS
[Adopted: December 4, 2003; Effective: February 12, 2004]

CHAPTER 790.
SEWAGE COLLECTION AND TREATMENT REGULATIONS.

PART I.
PROCEDURAL REGULATIONS.

Article 1.
Definitions and Terms.

9 VAC 25-790-10. Definitions.

Unless otherwise specified, for the purpose of this chapter the following words and terms shall have the following meanings unless the context clearly indicates otherwise:

"Area engineer" means the licensed professional engineer at the Department of Environmental Quality responsible for review and approval of construction plans and related materials who serves the area where a sewerage system or treatment works is located.

"Biosolids" means a sewage sludge that has received an established treatment for required pathogen control and is treated or managed to reduce vector attraction to a satisfactory level and contains limited levels of pollutants, such that it is acceptable for use by land application, marketing or distribution in accordance with the Biosolids Use Regulations (12 VAC 5-585) of the Code of Virginia.

"Board" means the Virginia State Water Control Board.

"CTC" means a Certificate to Construct issued in accordance with the provisions of this chapter. This certificate will normally be in the form of a letter granting authorization for construction.

"CTO" means a Certificate to Operate issued in accordance with the provisions of this chapter. This certificate will normally be in the form of a letter granting authorization for operation.

"Critical areas/waters" means areas/waters in proximity to shellfish waters, a public water supply, recreation or other waters where health or water quality concerns are identified by the Virginia Department of Health or the State Water Control Board.

"Conventional design" means the designs for unit operations (treatment system component) or specific equipment that has been in satisfactory operation for a period of one year or more, for which adequate operational information has been submitted to the department to verify that the unit operation or equipment is designed in substantial compliance with this chapter. Equipment or processes not considered to be conventional may be deemed as alternative or nonconventional.

"Department" means the Virginia Department of Environmental Quality.

"Director" means the Director of the Department of Environmental Quality or an authorized representative.

"Discharge" means (when used without qualification) discharge of a pollutant.

"Effluent limitations" means any restrictions imposed by the board on quantities, discharge rates, and concentrations of pollutants that are discharged from point sources into surface waters, the waters of the contiguous zone, or the ocean.

"Exceptional quality biosolids" means biosolids that have received an established level of treatment for pathogen control and vector attraction reduction and contain known levels of pollutants, such that they may be marketed or distributed for public use in accordance with this chapter.

"Indirect discharger" means a nondomestic discharger introducing pollutants to a POTW.

"Industrial wastes" means liquid or other wastes resulting from any process of industry, manufacture, trade or business, or from the development of any natural resources.

"Land application" means the distribution of treated wastewater of acceptable quality, referred to as effluent, or supernatant from biosolids use facilities or stabilized sewage sludge of acceptable quality, referred to as biosolids, upon, or insertion into, the land with a uniform application rate for the purpose of assimilation, utilization, or pollutant removal. Bulk disposal of stabilized sludge in a confined area, such as in landfills, is not land application.

"Licensee" means an individual holding a valid license issued by the Board for Waterworks and Wastewater Works Operators.

"Licensed operator" means a licensee in the class of the treatment works who is an operator at the treatment works.

"Local review" means a program for obtaining advance approval by the director of an owner's general local plans and specifications for future connections to, or extensions of, existing sewerage systems and of a plan for implementing them, in lieu of obtaining a CTC and CTO for each project within the scope of the plan.

"Manual" and "Manual of Practice" means Part III (9 VAC 25-790-310 et seq.) of the Sewage Collection and Treatment Regulations.

"Operate" means the act of making a decision on one's own volition (i) to place into or take out of service a unit process or unit processes or (ii) to make or cause adjustments in the operation of a unit process or unit processes at a treatment works.

"Operating staff" means individuals employed or appointed by any owner to work at a treatment works. Included in this definition are licensees whether or not their license is appropriate for the classification and category of the treatment works.

"Operator" means any individual employed or appointed by any owner, and who is designated by such owner to be the person in responsible charge, such as a supervisor, a shift operator, or a substitute in charge, and whose duties include testing or evaluation to control treatment works operations. Not included in this definition are superintendents or directors of public works, city engineers, or other municipal or industrial officials whose duties do not include the actual operation or direct supervision of a treatment works.

"Owner" means the Commonwealth or any of its political subdivisions, including, but not limited to, sanitation district commissions and authorities, and any public or private institution, corporation, association, firm or company organized or existing under the laws of this or any other state or country, or any officer or agency of the United States, or any person or group of persons acting individually or as a group that owns, operates, charters, rents, or otherwise exercises control over or is responsible for any actual or potential discharge of sewage, industrial wastes, or other wastes to state waters, or any facility or operation that has the capability to alter the physical, chemical, or biological properties of state waters in contravention of § 62.1-44.5 of the State Water Control Law.

"Permit" in the context of this chapter means a CTC or a CTO. Permits issued under 9 VAC 25-31 or 9 VAC 25-32 will be identified respectively as VPDES permits or VPA permits.

"Primary sludge" means sewage sludge removed from primary settling tanks designed in accordance with this chapter that is readily thickened by gravity thickeners designed in accordance with this chapter.

"Point source" means any discernible, confined and discrete conveyance, including, but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel or other floating craft from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture or agricultural storm water runoff.

"Pollutant" means dredged spoil, solid waste, incinerator residue, filter backwash, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials (except those regulated under the Atomic Energy Act of 1954, as amended (42 USC 2011 et seq.)), heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into the water. It does not mean:

1. Sewage from vessels; or

2. Water, gas, or other material that is injected into a well to facilitate production of oil or gas, or water derived in association with oil and gas production and disposed of in a well, if the well used either to facilitate production or for disposal purposes is approved by the board, and if the board determines that the injection or disposal will not result in the degradation of ground or surface water resources.

"Pollution" means such alteration of the physical, chemical or biological properties of any state waters as will, or is likely to, create a nuisance or render such waters (i) harmful or detrimental or injurious to the public health, safety or welfare, or to the health of animals, fish or aquatic life; (ii) unsuitable with reasonable treatment for use as present or possible future sources of public water supply; or (iii) unsuitable for recreational, commercial, industrial, agricultural or for other reasonable uses; provided that: (a) an alteration of the physical, chemical or biological property of state waters, or either a discharge, or a deposit, of sewage, industrial wastes, or other wastes to state waters by any owner, which by itself is not sufficient to cause pollution, but which, in combination with such alteration of, or discharge, or deposit to state waters by other owners is sufficient to cause pollution; (b) the discharge of untreated sewage by any owner into state waters; and (c) contributing to the contravention of standards of water quality duly established by the State Water Control Board are "pollution" for the terms and purposes of this chapter.

"Reliability" means a measure of the ability of a component or system to perform its designated function without failure or interruption of service.

"Responsible charge" means designation by the owner of any individual to have the duty and authority to operate a treatment works.

"Settled sewage" is effluent from a basin in which sewage is held or remains in quiescent conditions for 12 hours or more and the residual sewage sludge is not reintroduced to the effluent following the holding period. Sewage flows not in conformance with these conditions providing settled sewage shall be defined as nonsettled sewage.

"Sewage" means the water-carried and nonwater-carried human excrement, kitchen, laundry, shower, bath or lavatory wastes, separately or together with such underground, surface, storm and other water and liquid industrial wastes as may be present from residences, buildings, vehicles, industrial establishments or other places.

"Sewage sludge" or "sludge" means any solid, semisolid, or liquid residues which contain materials removed from municipal or domestic wastewater during treatment including primary and secondary residues. Other residuals or solid wastes consisting of materials collected and removed by sewage treatment, septage and portable toilet wastes are so included in this definition. Liquid sludge contains less than 15% dry residue by weight. Dewatered sludge contains 15% or more dry residue by weight.

"Sewerage system" or "sewage collection system" means a sewage collection system consisting of pipelines or conduits, pumping stations and force mains and all other construction, devices and appliances appurtenant thereto, used for the collection and conveyance of sewage to a treatment works or point of ultimate disposal.

"Shall" or "will" means a mandatory requirement.

"Should" means a recommendation.

"Sludge management" means the treatment, handling, transportation, use, distribution or disposal of sewage sludge.

"State waters" means all water, on the surface and under the ground, wholly or partially within, or bordering the state or within its jurisdiction.

"Substantial compliance" means designs that do not exactly conform to the guidelines set forth in Part III as contained in documents submitted pursuant to this chapter but whose construction will not substantially affect health considerations or performance of the sewerage system or treatment works.

"Subsurface disposal" means a sewerage system involving the controlled distribution of treated sewage effluent below the ground surface in a manner that may provide additional treatment and assimilation of the effluent within the soil so as not to create a point source discharge or result in pollution of surface waters.

"Surface waters" means all state waters that are not ground water as defined in § 62.1-255 of the Code of Virginia.

"Toxic pollutant" means any pollutant listed as toxic under § 307(a)(1) or, in the case of sludge use or disposal practices, any pollutant identified in regulations implementing § 405(d) of the Clean Water Act.

"Treatment works" means any device or system used in the storage, treatment, disposal or reclamation of sewage or combinations of sewage and industrial wastes, including but not limited to pumping, power and other equipment and their appurtenances, septic tanks and any works, including land, that are or will be (i) an integral part of the treatment process or (ii) used for ultimate disposal of residues or effluents resulting from such treatment. Treatment works does not mean either biosolids use facilities or land application of biosolids on private land, as permitted under the Biosolids Use Regulations (12 VAC 5-585).

"Virginia Pollution Abatement (VPA) permit" means a document issued by the board, pursuant to 9 VAC 25-32, authorizing pollutant management activities under prescribed conditions.

"Virginia Pollutant Discharge Elimination System (VPDES) Permit" means a document issued by the board, pursuant to 9 VAC 25-31, authorizing, under prescribed conditions, the potential or actual discharge of pollutants from a point source to surface waters and the use or disposal of sewage sludge. Under the approved state program, a VPDES permit is equivalent to an NPDES permit.

"Water quality standards" means the narrative statements for general requirements and numeric limits for specific requirements, that describe the water quality necessary to meet and maintain reasonable and beneficial uses. Such standards are established by the State Water Control Board under § 62.l-44.15(3a) of the Code of Virginia as the State Water Quality Standards (9 VAC 25-260).

Article 2.
Procedures.

9 VAC 25-790-20. Compliance with the Administrative Process Act.

The provisions of the Virginia Administrative Process Act (Chapter 40 (§ 2.2-4000 et seq.) of Title 2.2 of the Code of Virginia) and Chapter 3.1 (§ 62.1-44.2 et seq.) of Title 62.1 govern the adoption and enforcement of the regulations and standards contained in the chapter. All procedures outlined in this article are in addition to, or in compliance with, the requirements of that Act.

9 VAC 25-790-30. Extent.

A. Powers and procedures. The board reserves the right to utilize any lawful procedure for the enforcement of this chapter and standards contained in this chapter.

B. Establishment. Authority for the regulations and standards contained in this chapter for the operation, construction, or modification of sewerage systems or treatment works are established, pursuant to § 62.1-44.19 of the Code of Virginia.

C. Delegation. The director, or an authorized representative, may perform any act of the board provided under this regulation, except as limited by § 62.1-44.14 of the Code of Virginia.

9 VAC 25-790-40. Variances.

A. The director may grant a variance to a design or operational standard by following the appropriate procedures set forth in this chapter.

B. Requirements. The director may grant a variance if he finds that the hardship imposed (which may be economic) outweighs the benefits that may be received by the public and that the granting of such variance does not subject the public to unreasonable health risks or environmental pollution.

C. Application. Any owner may apply in writing for a variance. The application should be sent to the appropriate area engineer as specified, for evaluation. The application shall include:

1. A citation of the design or operational standard from which a variance is requested.

2. The nature and duration of variance requested.

3. A statement of the hardship to the owner and the anticipated impacts to the public health and welfare if a variance were granted.

4. Suggested conditions that might be imposed on the granting of a variance that would limit its detrimental impact on public health and welfare.

5. Other information, if any, believed to be pertinent by the applicant.

6. Such other information as may be required to make the determination in accordance with this chapter.

D. Consideration. The director shall act on any variance request submitted pursuant to this chapter within 60 days of receipt of request. In the director's consideration of whether a sewerage systems or treatment works variance should be granted, the director shall consider such factors as the following:

1. The effect that such a variance would have on the adequate operation of the sewerage systems or treatment works, including operator safety (in accordance with requirements of the Virginia Department of Labor and Industry, Occupational Safety and Health Administration (VOSH)).

2. The cost and other economic considerations imposed by this requirement;

3. The effect that such a variance would have on the protection of the public health and welfare, or the environment.

E. Disposition. The director will offer the owner an opportunity to participate or become informed as to the variance processing and decisions.

1. The director may grant the variance request and if the director proposes to deny the variance he shall provide the owner an opportunity to an informal fact-finding proceeding as provided in § 2.2-4019 of the Administrative Process Act. Following this opportunity for an informal fact-finding proceeding, the director may reject any application for a variance by sending a rejection notice to the applicant. The rejection notice shall be in writing and shall state the reasons for the rejection. A rejection notice constitutes a case decision.

2. If the director proposes to grant a variance request submitted pursuant to this chapter, or standards contained in this chapter, the applicant shall be notified in writing of this decision. Such notice shall identify the variance, the sewerage systems or treatment works involved, and shall specify the period of time for which the variance will be effective. Such notice shall provide that the variance will be terminated when the sewerage systems or treatment

works come into compliance with the applicable design or operational standard and may be terminated upon a finding by the director that the sewerage systems or treatment works has failed to comply with any requirements or schedules issued in conjunction with the variance. The effective date of the variance shall be 15 days following its issuance.

F. Posting. All variances granted for the design or operation of any sewerage systems or treatment works are nontransferable. Any requirements of the variance shall become part of the permit of the sewerage systems or treatment works subsequently granted by the director.

9 VAC 25-790-50. CTCs and CTOs.

A. No owner shall cause or allow the construction, expansion or modification (change of 25% or more in capacity or performance capability) of a sewerage system or treatment works except in compliance with a CTC from the director unless as otherwise provided for by this chapter and standards contained in this chapter. Furthermore, no owner shall cause or allow any sewerage systems or treatment works to be operated except in compliance with a CTO issued by the director which authorizes the operation of the sewerage systems or treatment works unless otherwise provided for by this chapter and standards contained in this chapter. Conditions may be imposed on the issuance of any CTC or CTO, and no sewerage systems or treatment works may be constructed, modified, or operated in violation of these conditions.

B. Discharges of 1,000 gpd or less. On-site (located within owners property) residential sewage treatment works having a design capacity of 1,000 gallons per day or less may not be governed by this chapter and standards contained in this chapter if the performance reliability of such technology has been established by an approved testing program (9 VAC 25-790-210). These treatment works are regulated by other applicable regulations of the board (9 VAC 25-110) and of the Virginia Department of Health (12 VAC 5-610 and 12 VAC 5-640). Owners of such treatment works shall make application in accordance with and obtain the necessary permits from the board or the Virginia Department of Health as appropriate via the application procedures established for such treatment works.

9 VAC 25-790-60. CTC and CTO waivers.

A. Small sewerage systems and treatment works. As described in this section, the requirement to formally obtain a CTC and a CTO through the provisions of this chapter and standards contained in this chapter is waived for sewerage systems having a design capacity of 40,000 gallons per day or less and serving or capable of serving a population of 400 persons or less and consisting entirely of gravity flow sewers.

B. Other waivers. A waiver for formal CTC and CTO issuance may also be granted for:

1. Construction of gravity flow sewers of 12-inch diameter design size or less;

2. Installations consisting of a single sewage pumping station having a design pumping capacity of 25 gallons per minute or less and handling a total daily volume of 2000 gallons or less;

3. Land application sites meeting the operational restrictions specified in the Virginia Department of Health Biosolids Use Regulations (12 VAC 5-585-130; or

4. Sites utilized entirely for research projects in accordance with this chapter, such as pilot plant studies.

C. Larger sewerage systems and treatment works. In order to qualify for a CTC and CTO waiver for collection systems serving more than 400 persons, the permittee or owner must file with the area engineer an application (see Part IV (9 VAC 25-790-940 et seq.) of this chapter) or a letter of intent to construct and operate such a system as described above. The letter shall be filed at least 30 days prior to the time that granting of such a waiver would be required to initiate construction. The letter shall contain a brief description of the proposed sewerage system, or land application, applicable maintenance provisions, the area to be served, the location of the proposed sewerage system, treatment works, or land application and the point of discharge or entry to the downstream sewerage system or treatment works if applicable. If the owner of the sewerage system or treatment works is not the applicant, the applicant shall demonstrate that the downstream owner will accept the design flow for connection to the downstream sewerage system or treatment works. A written statement that the additional sewage being discharged into the downstream system will be accepted may be required. If after review of the application or letter, a determination is made by the director that it is not in the best interest of public health and welfare to waive the permit requirements of this chapter and standards contained in this chapter, the owner will be so notified and will be required to obtain the applicable CTC and CTO. The requirements of this subsection are not applicable if the owner has a local review program pursuant to this chapter and standards contained in this chapter.

D. The director may revoke a waiver granted under this section in his sole discretion if he determines that the public health and welfare would be better served by issuance of a CTC and a CTO.

9 VAC 25-790-70. Reliability classification.

The department shall establish the reliability classification following discussion with the owner for inclusion in the engineer's design of the sewerage system or works. Reliability is a measurement of the ability of a component or system to perform its designated function without failure or interruption of service. Overflow criteria, such as a period of discharge, are utilized solely for the establishment of reliability classification for design purposes and are not to be construed as authorization for, or defense of, an unpermitted discharge to state waters. The reliability classification will be a major consideration for discussion at the preliminary engineering conference described in this chapter. Pump stations associated with, but physically removed from, the actual treatment works may have a different classification than the treatment works itself. The reliability classification shall be based on the water quality and public health and welfare consequences of a component or system failure. Guidelines for classifying sewerage systems and treatment works are as follows:

1. Reliability Class I. Sewerage systems or treatment works whose location, or discharge, or potential discharge (i) is sufficiently close to residences, public water supply, shellfish, or recreation waters; (ii) has a volume or character; or (iii) for which minimal dilution of 10 to 1, receiving water volume to discharge volume, based on permit flow values is not provided year round, such that permanent or unacceptable damage could occur to the receiving waters or public health and welfare if normal operations were interrupted.

2. Reliability Class II. Sewerage systems or treatment works whose location or discharge, or potential discharge, due to its volume or character, would not permanently or unacceptably damage or affect the receiving waters or public health and welfare during periods of short-term operations interruptions, but could be damaging if continued interruption of normal operation were to exceed 24 hours.

3. Reliability Class III. Sewerage systems or treatment works not otherwise classified as Reliability Class I or Class II.

Unless designated as applying to a particular reliability class, all requirements specified in this chapter and standards contained in this chapter apply equally to all reliability classes.

9 VAC 25-790-80. CTC procedures.

A. CTCs are issued by the director, but all requests for a CTC shall be directed initially to the area engineer that serves the area where the sewerage system or treatment works is located. The procedure for obtaining the permit includes one or more of the following steps:

1. The submission of an application;

2. A preliminary engineering conference;

3. The establishment of the reliability classification of the sewage collection or treatment works;

4. Submission and evaluation of a preliminary engineering proposal or concept;

5. The submission and evaluation of plans, specifications, design criteria and other data in the number requested by the area engineer;

6. The evaluation of an operation and maintenance manual;

7. The evaluation of a sludge management plan.

B. A formal technical evaluation involving a detailed engineering analysis of the plans, specifications and other design documents by the area engineer may be required. Advanced treatment designs (Article 8 of Part III), nutrient control designs (Article 10 of Part III), and alternative technology (9 VAC 25-790-210) will typically require a formal technical evaluation. A formal technical evaluation of submitted documents prior to issuance of a permit in accordance with this chapter may be waived following a review of the preliminary engineering proposal or concept provided that the owner's consultant submits a statement that the design will meet the requirements established through this chapter and standards contained in this chapter.

C. Notification. Informal and formal technical evaluations will be completed and the owner notified at least informally of the resulting decision within 30 days of receipt of complete documents unless the director grants the area engineer additional time to complete such evaluations on a specified design. In addition, written notice of the decision will be provided to the owner no later than 15 days after completion of the evaluation.

9 VAC 25-790-90. CTC application.

All applications for a CTC shall be submitted on a form provided by the department and shall be submitted by the owner or authorized agent to the appropriate area engineer as specified at least 30 days of the time an owner desires to be notified of the required procedure for issuance of a CTC, or at least 180 days prior to the date that the owner desires to begin construction. An application for a CTC or a sewerage system shall be accompanied by notification that local government will issue necessary approvals and design data verifying that downstream capacity is available to adequately convey and treat the design flows in accordance with these regulations. An application for a CTC for a sewerage system or treatment works will not be considered complete until evidence is submitted that a complete application has been submitted for a VPDES permit or VPA permit. The owner will be notified by the department within 30 days of receipt of a complete application if a technical evaluation of preliminary or final design documents is required following the preliminary engineering conference, if held.

9 VAC 25-790-100. Preliminary engineering conference.

A preliminary conference with the appropriate area engineer as specified will be held within 15 days of the owner's request for the meeting for proposed treatment works and pump station designs to establish the requirements for submission of the information necessary for a determination by the director relating to the issuance of a CTC. The applicant's engineer shall be prepared to set forth the sewage collection or treatment problems and the proposed solution in such a manner as to support the conclusions and recommendations presented at this meeting. A preliminary engineering proposal may be submitted prior to, during, or following the preliminary conference. Minutes of the meeting shall be recorded and distributed to the concerned parties.

9 VAC 25-790-110. Preliminary engineering proposal.

A. Objective. The objective is to facilitate a determination by the department that the proposed design selected by the owner either requires, or does not require, submission of design documents for a formal technical evaluation to establish that the following standards will be reliably met by operation of the facility or system: (i) compliance with effluent limitations and treatment requirements established by the board; and (ii) conformance with applicable minimum requirements established by this chapter and standards contained in this chapter, in order that a CTC be issued.

B. Content. The preliminary engineering proposal when submitted for evaluation shall consist of an engineering report and preliminary plans which shall contain the necessary data to portray the sewerage system or treatment works problems and solutions. The requirement for a complete preliminary engineering proposal for small flow or minor projects (design flow less than one million gallons per day (mgd)) can be waived by the department in accordance with the letter from the owner's engineer summarizing the agreements reached at the preliminary engineering conference. For all proposals involving sewerage systems or treatment works, whether new or upgraded, the engineer shall make an evaluation of the l00-year flood elevation at the proposed site or sites, using available data and sound hydrologic principles. If a flood potential is indicated, the flood plain boundaries shall be delineated on a site map, showing its relation to the proposed facility or facilities and actions proposed to comply with this chapter shall be included in the preliminary engineering proposal or with the letter summarizing the agreements reached at the preliminary engineering conference. A conceptual plan for closure of the treatment works shall be discussed prior to final design to anticipate such an occurrence. On major projects (design flow of 1 mgd or more) excluding sewerage systems that are exempted from technical evaluation, the preliminary engineering proposal can include as a minimum the following information as applicable:

1. Mapping of present site location and evaluation of site constraints.

2. Data supporting predicted service population.

3. Identification of specific service area for immediate consideration and possible extensions.

4. Data, including reliable measurements or predictions of design flow and analyses of sewage constituents as a basis of process design.

5. Description of treatment process and flow plans identifying the proposed arrangement of basins, piping and related equipment with unit operation design parameters and sizes.

6. Description of sludge management method.

7. Plan for imposed operations requirements, i.e., certain unit operations may be required to operate independently of others in accordance with the reliability classification, while achieving the treatment performance necessary to meet permit limits under average design conditions.

8. Demonstration of compliance with state and local laws and regulations.

9. Summary of findings, conclusions and recommendations.

10. Description of existing institutional constraints or other unresolved problems that influence selection of alternative solutions.

11. Estimate of capital and operating costs of all alternatives presented if available as public information.

12. For those projects for which a Virginia Revolving Loan will be requested, the ways in which the special requirements contained in Title II of P.L. 92-500 will be met (infiltration, cost effectiveness, etc.).

13. Staffing and operating requirements for facility.

14. Identification consistent with all applicable area wide plans, of drainage basin, service area, and metropolitan area plans.

15. Designation of owner's representative for design purposes.

16. For land application proposals, the information required by Part III (9 VAC 25-790-310 et seq.) of this chapter, as appropriate.

The format for the Preliminary Engineering Proposal is listed in Part IV (9 VAC 25-790-940 et seq.) of this chapter.

C. Approval. The department will approve or disapprove the preliminary engineering proposal and notify the owner in accordance with 9 VAC 25-790-80 C.

9 VAC 25-790-120. Construction drawings (plans).

A. Construction drawings (plans) for sewerage systems or treatment works improvements for which a technical evaluation is required shall provide the information necessary to determine that the owner's final plans, specifications, and other documents satisfy (i) requirements established by these regulations and engineering standards of practice; and (ii) the minimum requirements and limiting factors established in the owner's approved preliminary engineering proposal. The final plans should include:

B. Final engineering documents. Drawings, plans, specifications and other engineering documents that are submitted to the area engineer for a technical evaluation shall be in substantial compliance with this chapter prior to issuance of a CTC by the director. Engineering documents may be submitted by the owner to the area engineer following the preliminary engineering conference, or following a technical evaluation of the preliminary engineering proposal if required. Up to four copies shall be submitted to the area engineer for non-Virginia Revolving Loan Fund funded projects and up to five copies shall be submitted for projects financed through the Virginia Revolving Loan Fund. The original of the letter of submittal with appropriate signature(s) shall accompany the engineering documents. The letter of submittal should identify any necessary actions to be taken by the area engineer to expedite evaluation of the submitted documents.

All drawings, specifications, engineer's reports and other documents submitted for evaluation shall be prepared by or under the supervision of appropriately licensed professionals, legally qualified to practice in Virginia, in accordance with the provisions of §§ 54.1-400 to 54.1-411 of the Code of Virginia inclusive.

All submitted plans for sewerage systems or treatment works shall bear a suitable title showing the name of the municipality, sewer district, institution or other owner and shall show the scale in feet, a graphical scale, the north point, date and the name of the appropriate licensed professional. Also, each plan sheet shall bear the same general title identifying the overall project, and each shall be numbered. Appropriate subtitles shall be included on the individual sheets. The plans shall be clear and legible. They shall be drawn to a scale that will permit all necessary information to be plainly shown. The size of the plans should be no larger than 36 inches by 48 inches. The datum used should be indicated. Locations of all special features, when made, shall be shown on the plans. Logs of test borings should be given either on plans or in the specifications. Detail plans shall consist of plan views, elevations, sections, and supplementary views which, together with the specifications and general layouts, provide the working information for the contract and construction of the works. The plans shall include dimensions and relative elevations of structures, the location and outline form of equipment, location and size of piping, water levels, ground elevations, and erosion control abatement facilities. Data shall be provided for proposed additions of flow to existing sewerage systems indicating that the additional sewage flow from the proposed project will have no adverse impact on the operation of downstream facilities.

C. Sewerage systems. Plans submitted for new construction or substantial modification (increasing flow capacity by more than 25%) of sewage collection piping shall include the following: the location, size, type and direction of flow of all existing and proposed sanitary sewers involved in the project.

1. Detailed plans when submitted for evaluation shall provide complete and properly scaled graphical depictions of design information. Profiles shall have a horizontal scale of not more than 100 feet to the inch and a vertical scale of not more than 10 feet to the inch. The plan view shall be drawn to a corresponding horizontal scale. Plans and profiles shall show:

a. Location of streets and sewers with an identification system.

b. Ground surface elevations and manhole stationing.

c. Invert elevations of sewers at each manhole.

d. Size and grade of sewer between adjacent manholes.

e. Any special construction features.

2. All manholes shall be labeled in an established manner on the plan and correspondingly labeled on the profile. If a community does not allow the connection of basement drains to the sewer, this may be stated on the plans as a

basis for exemption, and the plans need not show the elevations and locations of basement floors. Where there is any question of the sewer being sufficiently deep to serve any residence, the elevation and location of the basement floor shall be plotted on the profile of the sewer which is to serve the house in question. The engineer shall state that all sewers are sufficiently deep to serve adjacent basements except where otherwise noted on the plans.

3. Sewerage system plans shall identify locations of all special features such as inverted siphons, concrete encasement, elevated sewers, all known existing structures both above and below ground that might interfere with the proposed construction, particularly water mains, gas mains, storm drains, etc.

4. Special detail drawings, made to a scale to clearly show the nature of the design, shall be furnished to show the following particulars:

a. All stream crossings and sewer outlets, with elevations of the streambed and normal and design flow water levels.

b. Details of all sewer joints and cross sections requiring special construction such as concrete encasement.

c. Details of all sewer appurtenances such as manholes, inspection chambers, inverted siphons, regulators, tide gates and elevated sewers.

D. Sewage pumping stations. Plans submitted for technical evaluation involving new construction or substantial modification (increasing flow capacity by more than 25%) of pumping stations shall address the following design information: (i) the location and extent of the tributary area; (ii) the location of municipal boundaries within the tributary area; and (iii) the location of the pumping station and force main and pertinent elevations.

1. For new construction the forms of land use (commercial, residential, and agricultural) and access control proposed for the near future over a 100-foot radius from the pumping station structure shall be indicated. Existing buildings and their types within 100 feet of the pumping station shall be indicated. Submission of detailed plans would not be required for upgraded pump stations that are issued, or included in, a final operating permit.

2. Detailed plans submitted for evaluation shall provide the following design information where applicable:

a. A contour map of the property to be used.

b. Proposed pumping station equipment layout and capacities including provisions for installation of future pumps or ejectors. Proper references to the specifications should be included.

c. Elevations of operating levels of sewage contained in the wet well at the site and the estimated locations of raw sewage overflows in the collection system upon occasion of pump failure resulting in high water levels in the wet well.

d. Test borings and ground water elevations, if taken.

e. Plan and elevation views of the pump suction (from the wet well) and discharge piping showing all isolation valves and gates.

E. Treatment works. Plans submitted for technical evaluation of projects involving new construction or substantial modifications (increasing flow capacity by more than 25%) of treatment works shall identify the treatment works relative to the remainder of the system. For new construction, the plan shall include sufficient topographic features to indicate its location relative to streams and the point of discharge of treated effluent. Also the forms of land use (commercial, residential, and agricultural, existing or proposed) and access controls for the near future over a 700-foot radius from the proposed treatment works structures must be indicated. Existing buildings and their type of use within 700 feet of the new treatment works site shall be adequately described, e.g., by means of topographic maps, aerial photos, drawings, etc.

1. For technical evaluation, the proposed treatment works design submittal shall include the following as specified:

a. Topography and other characteristics of the site as specified:

b. Size and location of treatment works structures.

c. Schematic flow diagram showing the flow through various treatment works unit operations.

d. Piping, including any arrangements for bypassing individual unit operations. Materials handled and direction of flow through channels, pipes and unit operations shall be shown, including arrangements for independent operation.

e. Hydraulic flow profiles showing the average relative surface elevations of mainstream and sidestream flows of sewage, supernatant and sludge as influent, effluent and flow within the channels, piping, pumps and basins that comprise the treatment works.

f. Soil characteristics including hydraulic conductivity established by soil tests and test borings and hydrologic factors, such as ground water elevations, that can affect the treatment of disposal capacity.

2. For technical evaluation, detailed plans shall include the following:

a. Location, dimensions and elevations of all existing and proposed treatment works unit operations solids handling facilities and equipment.

b. Elevations of high water levels affecting the treatment works design and to which the treatment works effluent is to be discharged or absorbed.

c. Pertinent data concerning the rated capacity of all pumps, blowers, motors and other mechanical devices. All or part of such data may be included in the specifications by suitable reference on the plans.

d. Average and maximum elevations for the hydraulic flow profile within the unit operations.

e. Adequate description of any features not otherwise covered by specifications or engineer's report.

3. Facility closure plans shall address the following information as a minimum:

a. Residual wastewater and solids treatment, removal and final disposition.

b. Removal of structures, equipment, piping and appurtenances.

c. Site grading and erosion and sediment control.

d. Restoration of site vegetation and access control.

e. Proposed land use (post-closure) of site.

F. Approval. The area engineer will approve or disapprove the construction drawings and notify the owner in accordance with 9 VAC 25-790-80 C.

9 VAC 25-790-130. Specifications.

A. Content. Complete technical specifications for the construction of sewers, sewage pumping stations, treatment works, including subsurface disposal pre-treatment and all appurtenances, shall accompany the plans submitted for technical evaluation.

The specifications accompanying construction drawings shall include, but not be limited to, all construction information not shown on the drawings which is necessary to inform the contractor in detail of the design requirement as to the quality of materials and workmanship and fabrication of the project and the type, size, strength, operating characteristics and rating of equipment, including machinery, pumps, valves, piping, and jointing of pipe, electrical apparatus, wiring and meters; laboratory fixtures and equipment; operating tools, construction materials, special filter materials such as stone, sand, gravel or slag; miscellaneous appurtenances; chemicals when used; instructions of testing materials and equipment as necessary to meet design requirements and standards of practice; and operating tests for the completed works and component units.

B. Submittal. Specifications shall be submitted to the area engineer in the number and distribution specified in this chapter. One copy of the submitted documents shall bear on an initial page the original seal imprint and signature of the appropriately registered professional who prepared the specifications or under whose direct supervision the specifications were prepared for electronic submission of documents. For electronic submittal of documents, a transmittal letter shall bear the original seal and signature. Submission of specifications for gravity systems to the area engineer will not be required for those municipalities or privately owned sewerage systems that are either approved to participate in the local review program or have received department approval of local standards for design and construction. Local review participation requirements are described in 9 VAC 25-790-230.

C. Approval. The area engineer will approve or disapprove the specifications and notify the owner in accordance with 9 VAC 25-790-80 C.

9 VAC 25-790-140. Operation and maintenance manuals.

A. Content. Operation and maintenance manuals including the monitoring and operating requirements contained in 9 VAC 25-790-260 through 9 VAC 25-790-300 shall be prepared for all sewerage systems, pumping stations, and treatment works evaluated in accordance with this chapter, except as noted in this chapter. Owners shall submit updated information for any operational changes that affect treatment capacity or operational performance by 25% or more. Manuals for new construction or revised pages for existing but modified (upgraded) facilities submitted to the area engineer for evaluation will also be processed.

Copies of the manual submitted to the area engineer shall be in the number up to that specified for plans. An evaluation will not commence until the applicant has submitted all necessary information (see 9 VAC 25-790-950).

B. Evaluation. The department will evaluate the technical contents of the manual and will notify the owner (and manual preparer if appropriate) of the approval of the manual, or of any necessary revisions to the manual. The owner is responsible for ensuring that the required revisions are made and submitted to the department. If the additions or revisions to the manual are deemed satisfactory the department may not formally notify the owner who may implement those changes.

C. Approval. The department will approve or disapprove the manual and notify the owner in accordance with 9 VAC 25-790-80 C. If the manual is conditionally approved as submitted, such notification will include the conditions, if any, which must be satisfied for final approval. The owner will be responsible for ensuring that such conditions are satisfied in accordance with the CTO (9 VAC 25-790-190).

9 VAC 25-790-150. Sludge management plans.

A. Evaluation. The general purpose of the plan is to facilitate a determination by the department that the management plan developed by the owner in accordance with the department administered VPDES or VPA permit program (9 VAC 25-31 and 9 VAC 25-32) presents the necessary technical guidance and regulatory requirements to facilitate the proper management of sewage sludge for both normal conditions and generally anticipated adverse conditions. The evaluation by the department may address methods of controlling and monitoring the quality of sludge by the owner and the means of use or disposal of that sludge by the owner or his agent.

B. Approval. The department will approve or disapprove the manual and notify the owner in accordance with 9 VAC 25-790-80 C.

9 VAC 25-790-160. Formal requirements for the submission of engineering data.

In accordance with the provisions of §§ 54.1-400 to 54.1-411 of the Code of Virginia, inclusive, all drawings, specifications, and engineer's reports submitted for approval shall be prepared by or under the supervision of a licensed professional engineer legally qualified to practice in Virginia. One copy of the submitted documents, including drawings, the engineer's report, and the specifications submitted for review and evaluation, shall bear the signed imprint of the seal of the licensed professional engineer who prepared or supervised the preparation and be signed with an original signature. For electronic submission of documents, a transmittal letter shall bear the original seal and signature. In addition, each drawing submitted shall bear an imprint or a legible facsimile of such seal. Submissions of technical information for evaluation by the department shall identify the appropriate qualifications of the preparer of such information (i.e., license or certification).

9 VAC 25-790-170. Processing of plans, specifications and other engineering documents.

All reports, construction drawings, specifications and operation and maintenance manuals submitted to the department must be received at least 90 days prior to the date upon which action by the department is desired. If the plans and specifications are found to be incomplete or inadequate for detailed evaluation, the department will notify the party submitting the documents of the information necessary for a complete submittal within 30 days of receipt of the plans and specifications. If revisions to the plans or specifications are necessitated, a letter will be sent to the engineer who prepared them within 30 days of receipt outlining the necessary revisions. Revised plans or specifications constitute a resubmittal; therefore, additional time will be necessary for the review and technical evaluation (9 VAC 25-790-80 C). The owner may request the approval to begin construction prior to this notification in accordance with the provisions of this chapter. Preliminary plans and the engineer's report should be submitted for review and evaluation prior to the preparation of final plans unless the area engineer has agreed to omit this step in the evaluation process. One set of the approved plans and specifications will be stamped by the area engineer and returned to the owner.

9 VAC 25-790-180. CTC.

A. Issuance. Upon approval of the proposed design by the area engineer, including any submitted plans and specifications, if required, the director will issue a CTC to the owner within 15 days of such approval to construct or modify his sewerage systems or treatment works in accordance with the approved design and submitted plans and specifications.

B. Revisions. Any deviations from the approved design or the submitted plans and specifications significantly (25% or more variation from original) affecting hydraulic conditions (flow profile), unit operations capacity, the functioning of the sewage treatment process, or the quality of treated effluent discharged, must be approved by the area engineer before any such changes are made. Revised plans and specifications shall be submitted in time to allow 30 days for the review, evaluation and approval of such plans or specifications before any construction work that will be affected by such changes is begun, unless the owner has received approval to proceed from the department prior to either a formal submittal of revisions, or the department approval of submitted revisions.

C. Completion of construction. A statement shall be submitted by the owner assuring completion of construction and an inspection of the constructed system works will be scheduled in accordance with the provisions of this chapter.

1. Upon completion of the construction or modification of the sewerage systems or treatment works, the owner shall submit to the area engineer a statement signed by a licensed professional engineer stating that the construction work was completed in accordance with the approved plans and specifications, or revised only in accordance with the provisions of subsection B of this section. This statement is called a Statement of Completion of Construction and shall be based upon inspections of the sewerage systems or treatment works during and after construction or modifications that are adequate to ensure the truth of the statement.

2. The owner shall contact the area engineer and request that a final inspection of the completed construction be made so that either a conditional, or a final, CTO can be issued. Within 30 days after placing a new or modified sewerage systems or treatment works into operation, the effluent produced should be sampled and tested in a manner sufficient to demonstrate compliance with approved specifications and permit requirements. The area engineer shall be notified of the time and place of the tests and the results of the tests shall be sent to the area engineer for evaluation as part of the final CTO.

3. A closure plan should be submitted with or prior to the statement of completion of construction in accordance with this chapter.

9 VAC 25-790-190. CTO.

A. Issuance. Upon receipt of the construction completion statement, the director may issue a final CTO. However, the director may delay the granting of the CTO pending inspection, or satisfactory evaluation of effluent test results, to ensure that the work has been satisfactorily completed.

B. Conditional CTO. A conditional CTO may be issued specifying final approval conditions, with specific time periods, for completion of unfinished work, submission of operations and maintenance manual, sludge management plans, or other appropriate items.

The director may issue a conditional CTO to owners of sewerage systems or treatment works for which the required information for completion of construction has not been received. Such CTOs will contain appropriate conditions requiring the completion of any unfinished or incomplete work including approval of a closure plan and subsequent submission of the statement of completion of construction.

C. Final CTO. Consideration will be given to issuance of an interim CTO to individual unit operations of the treatment process system so as to allow utilization of these unit operations prior to completion of the total project. A final CTO shall be issued upon verification that the requirements of this chapter have been complied with.

9 VAC 25-790-200. CTO modifications or revocation actions.

A. Amendment or reissuance. The director may amend or reissue a CTO where there is a change in the manner of the collection, the treatment, or the source of sewage at the permitted location, or for any other cause incident to the protection of the public health and welfare, provided notice is given to the owner, and, if one is required, a hearing held in accordance with the provisions of the Administrative Process Act.

B. Revocation or suspension. The director may suspend or revoke a CTO in accordance with the Administrative Process Act for the following reasons:

1. Failure to comply with the conditions of the CTO.

2. Violation of Title 62.1 of the Code of Virginia or of any of this chapter from which no variance or waiver has been granted.

3. Change in ownership.

4. Abandonment of the sewerage systems or treatment works.

5. Any of the grounds specified in § 62.1-44.2 of the Code of Virginia.

VAC 25-790-210. Nonconventional methods, processes or equipment.

A. Policy. The policy of the department is to encourage the development of any new or nonconventional methods, processes and equipment that appear to have application for the treatment or conveyance of sewage. Sewage treatment methods, processes and equipment may be subject to a special permit application procedure if (i) they are not covered by the Manual of Practice (Part III (9 VAC 25-790-310 et seq.) of this chapter) and (ii) they are in principle, or application, deemed to be nonconventional.

B. Provisional CTO. The performance reliability of nonconventional processes and equipment shall have been thoroughly demonstrated through an approved testing program for similar installations (loadings of 75% or more of design level) before they may be considered for conventional approval and use. Where the department approves such a testing program, a provisional CTO will be issued for treatment works in which new or nonconventional processes and equipment are to be evaluated. The provisional CTO will specify conditions related to the testing requirements and agreements necessary for issuance of a final CTO. The owner of the facility shall submit the required test results to the department according to an approved schedule for approval prior to issuance of a final CTO. It is the owner's responsibility to operate in compliance with requirements imposed by permits issued for the sewerage system or treatment works.

C. Assurance resources. As a prerequisite to the issuance of a provisional CTO, the owner must furnish assurance of financial ability or resources available to modify, convert, or replace, the new or nonconventional processes or equipment in the event the performance reliability cannot be established over the period of time specified by the provisional CTO. These assurances may be in the form of funds placed in escrow, letters of credit, performance bonds, etc., which would revert to the facility owner if performance reliability cannot be established.

D. Performance reliability testing. All procedures used in testing of the performance reliability shall be conducted under the supervision of a licensed professional engineer who shall attest to the accuracy of sampling and testing procedures. The required samples shall be tested through a qualified laboratory. The testing program shall provide as a minimum the following:

1. Samples shall be collected at designated locations at a stated frequency and analyzed in accordance with provisions of the provisional CTO. The minimum testing period shall be 12 months under the comparable environmental and operational conditions for which the process and equipment will receive conventional approvals for any additional installations.

2. All analyses shall be made in accordance with the 19th Edition of Standard Methods for the Examination of Water and Wastewater (1995) and 40 CFR Part 136 (July 1, 2003), or other approved analytical methods.

E. CTC. After the area engineer evaluates the plans and testing data, the director can issue a CTC if the performance data verifies that the method, process, or equipment can perform reliably in accordance with the design specifications and the operation standards of Part II, and that the method, process, or equipment may be installed as conventional for similar site specific operation.

F. Provisional CTO. Upon completion of construction or modification, a provisional CTO for a definite period of time will be issued for the operation of the nonconventional methods, processes, and equipment. Not more than one provisional CTO will be granted for a similar installation during the evaluation period. The provisional CTO shall require that:

1. The evaluation period shall be a minimum of 12 months and no longer than 18 months,

2. The holder of a provisional CTO must submit reports on operation during the evaluation period. The reports shall be prepared by either a licensed professional engineer experienced in the field of environmental engineering, the owner's operating or engineering staff, or a qualified testing firm.

G. Final CTO. The director will issue a final CTO upon lapse of the provisional CTO, if, on the basis of testing during that period, the new or nonconventional method, process, or equipment demonstrates reliable performance in accordance with permit requirements and the operation standards of Part II. If the standards are not met, then the owner shall provide for modification of the sewerage systems or treatment works, in a manner that will enable those standards to be met in accordance with this chapter.

9 VAC 25-790-220. Local review for sewerage systems.

In lieu of obtaining a CTC and CTO for each sewage collection project, an owner may elect to obtain approval for a master plan and subsequent local review for connections to, or extensions of, existing sewerage systems. The area engineer will provide technical review support for review of such requests. The following procedure for obtaining the approval for local review shall be used:

1. Local plans and specifications. The owner shall develop, adopt, and request approval of general local specifications and plan details covering sewage collection design and construction. For local government or owner approvals, the sewerage system owner must provide for preparation and evaluation of design documents either within the appropriate local government agency, or by separate professional entities or firms, and submit a formal description of such arrangements to the area engineer for evaluation and approval by the director.

2. Master plan. The owner shall develop a plan which outlines the following system specific requirements and the owner's method of compliance with such requirements:

a. Design criteria and construction specifications used by the owner,

b. Evidence that personnel with the training and experience necessary to ensure compliance with the program requirements are employed by the owner,

c. Location of interceptors and force mains, with design flows, for each designated service area within the collection systems conveying flow to the treatment works, and

d. A certificate method for certifying that sewerage system projects meet the requirements of these regulations, and that the project is in compliance with the master plan and local standards and specifications approved by the director.

The local owner approval certificate should describe the project to be constructed in accordance with bid documents and provide for the identification, position and signature of the local official responsible for project oversight.

3. Extensions. Sewer line extensions shall not be undertaken if such construction results in an increase in the number of equivalent residential connections (total flow divided by the product of 100 gpd times the service population), unless the receiving sewerage system and treatment works have been issued a final CTO in accordance with this chapter verifying that there is adequate capacity to handle the project design flows.

4. Sewerage systems covered by this section will not be issued separate CTOs unless special operation requirements dictate a need for permit issuance.

9 VAC 25-790-230. Compliance with Part II (9 VAC 25-790-260 et seq.--Operational Regulations) of this chapter.

A. CTOs issued prior to July 1, 2003. CTOs issued by either the board (including joint certificates to operate) or through the local health department, prior to July 1, 2003, shall continue in force until reissued or amended in accordance with this chapter.

B. Monitoring. All sewerage systems and treatment works owners shall comply with the Part II operational regulations except as provided in accordance with this chapter. Any owner may request technical assistance from the area engineer as necessary to implement corrective action. The director may require the owner or operator of any sewerage systems or treatment works to: (i) develop either an operation plan or an operation and maintenance manual for approval by the department and (ii) install, use, and maintain monitoring equipment for internal process testing of sewage flowing through the treatment works in order to identify and determine the causes of operational problems and to determine the necessary corrective actions to correct such problems. If required, test results shall be recorded, compiled, and reported to the area engineer in a format approved by the department.

9 VAC 25-790-240. Compliance with Part III (9 VAC 25-790-310 et seq.--Manual of Practice) of this chapter.

A. The design guidelines set forth in Part III (9 VAC 25-790-310 et seq.) of this chapter specify general criteria and minimum standards for the design and construction of sewerage systems and treatment works and are not intended to be used as a substitute for engineering experience and judgment used in accordance with standards of practice.

B. Additional standards. The director may impose standards and requirements which are more stringent than those contained in Part III of this chapter when required for critical areas or special conditions. Any such special standards and requirements including those associated with a State Revolving Loan program shall take precedence over the criteria in Part III of this chapter and will be items that warrant careful consideration at the preliminary engineering conference referenced in this chapter. Designs submitted for sewerage systems or treatment works must demonstrate that the system or works will adequately safeguard public health and welfare and will comply with the CTO and VPDES or VPA permit requirements, as appropriate.

C. Substantial compliance. Submissions that are in substantial compliance with Part III (9 VAC 25-790-310 et seq.) of this chapter or additional requirements of the department as noted above will be approved. Justification for a design may be required for those portions of the submitted design which differ from these criteria. The design engineer shall identify and justify noncompliance with specific design standards or "shall" criteria that the department identifies, or that the design engineer, in his judgment, believes to be substantial in nature. The department may request changes in designs that are not in substantial compliance with Part III of this chapter and that are not adequately justified by the engineer/owner.

D. Exceptions. Compliance with Part III of this chapter will not be required for sewerage systems or treatment works that have received the approval of the Virginia Department of Health and the board and on which modifications and construction have been commenced prior to February 27, 2002. Construction or modification of sewerage systems or treatment works is deemed to be commenced for purposes of this chapter upon receipt of complete final engineering documents by the area engineer. The fact that significant work was accomplished on a specific project prior to adoption of this chapter and standards contained in this chapter shall be a consideration when evaluating applications.

9 VAC 25-790-250. Sewage Collection and Treatment Advisory Committee.

A. The director shall appoint a Sewage Collection and Treatment Regulation Committee consisting of at least eight appointed members and four ex-officio members as specified in this section. Advisory committee membership should be representative of large size and small size communities and their consultants.

B. Organizations. Appointed committee members shall be selected from organizations such as:

a. The Virginia Water Environment Association (VWEA).

b. Virginia Association of Municipal Wastewater Agencies (VAMWA).

c. Virginia Society of Professional Engineers.

d. Sewerage Systems and Treatment Works Owners.

e. Consulting Engineers Council of Virginia.

f. State universities and college faculty.

Consideration shall also be given to appropriate citizens who are not members of these organizations and other interested parties and groups such as the Citizens Conservation Network.

C. Terms. All terms for appointed members should be four years in duration, and members shall not be appointed for more than two consecutive terms. Four of the eight appointed members shall serve an initial term of two years with subsequent terms of four years.

The director will designate two ex officio members from the department, and the Commissioner of the Virginia Department of Health shall be requested to designate one ex officio member from his staff. Each committee member may designate an alternate to serve when necessary. The secretary to the committee will be a staff member of the department.

D. Purpose. The function of the committee will be to meet, discuss issues, and make recommendations directly to the director, concerning this chapter and standards contained in this chapter and other policies, procedures, and programs for regulating sewerage systems and treatment works. The committee will meet semi-annually or more frequently at the call of the chairman. The committee's meeting will be advertised and open to the public, and comments and recommendations from the public will be received.

PART II.
OPERATIONAL REGULATIONS.

Article 1.
Monitoring.

9 VAC 25-790-260. Influent and effluent monitoring.

A. Methods. Sampling and testing methods shall conform to permit requirements, or if not specified, to current United States Environmental Protection Agency (EPA) guidelines establishing test procedures for analysis of pollutants or other EPA approved methods.

B. Schedule. The operation and maintenance manual shall contain a specific testing schedule of the minimum tests and their frequencies to be conducted by the facility in accordance with the appropriate certificate and permit issued. If not specifically addressed in the issued certificate and permit, influent and effluent monitoring shall be in accordance with this schedule. Typical tests are listed in 9 VAC 25-790-960.

C. Sampling. The following sampling instructions shall be followed when collecting samples as required to comply with this chapter and standards contained in this chapter.

1. Raw sewage samples are be collected prior to the treatment process unit operations; samples may be collected following the bar screen or comminutor.

2. Final effluent samples are to be taken at a point following all unit operations in the treatment process. An evaluation of chlorine reduction or dechlorination methods will require monitoring of chlorine residual and fecal coliform levels in treated sewage flows following the chlorine contact tank.

3. Chlorine residual, fecal coliform, pH, temperature and DO test samples may consist of grab samples of sewage flow obtained immediately prior to analytical measurements.

4. Compositing of samples shall be in accordance with the treatment works operation and maintenance manual. Composite samples of sewage flows shall consist of grab samples taken at a minimum frequency of one per hour and should be combined in proportion to flow. Greater frequency of grab sampling may be desirable where abnormal variation in waste strength occurs. Automatic flow proportional samplers are considered a valid sampling method.

9 VAC 25-790-270. Operational testing and control.

A. Methods. Sampling and testing methods shall conform to the issued certificate and permit requirements. In addition, current United States Environmental Protection Agency (EPA) guidelines and test procedures for analysis of pollutants may be used, as well as other EPA recommended methods.

B. Schedule. The operation and maintenance manual shall contain a specific schedule of the minimum tests and their frequency to be conducted by the treatment works and sampling instructions. Tests and sampling shall be in accordance with the requirements established by the instructions contained in the treatment works' operation and maintenance manual. Typical tests and sampling instructions are contained in this chapter.

C. Information. If necessary, additional operational control information may be requested on an individual treatment works basis by the department to evaluate performance reliability.

D. Records.

1. The owner shall maintain records on the treatment works operation, maintenance and laboratory testing. The records shall be available for review by department and area engineer during inspections at reasonable times. Any records of monitoring activities and results shall include at least the following for all samples:

a. The date, place, and time of sampling or measurements.

b. Individual that performed the sampling or measurements.

c. The dates analyses were performed.

d. Individual that performed analysis.

e. The analytical techniques or methods used.

f. The results of such analyses.

2. The owner shall maintain for a minimum of three years any records of monitoring activities and results, including all original strip chart recordings for continuous monitoring and instrumentation and all calibration and maintenance records. This period of retention shall be extended during the course of any unresolved litigation regarding the discharge of pollutants by the owner or upon the request of the director.

9 VAC 25-790-280. Land based monitoring system.

A. Land application of effluent. The Operation and Maintenance Manual shall contain a schedule of required minimum tests and their frequency to be conducted for the land treatment system and shall also contain instructions for recording and reporting. Monitoring, reporting, and recording for land treatment systems shall be in accordance with the treatment works' Operation and Maintenance Manual. Information concerning monitoring, recording and reporting for land application of effluent are contained in this chapter.

B. Sewage sludge and residual solids management. Either the Operation and Maintenance Manual or the sludge management plan shall contain a list of required minimum tests to be conducted for the sewage sludge and residual solids management system and shall also contain instructions for recording and reporting. Monitoring, reporting, and recording requirements for sewage sludge and residual solids management shall be in accordance with the sludge management plan or operation plan in accordance with this chapter and the Biosolids Use Regulations (12 VAC 5-585). Suggested monitoring, reporting, and recording for sewage sludge and residual solids management are described in this chapter. The record keeping and reporting requirements for sewage sludge and residual solids management contained in the treatment works Operation and Maintenance Manual or sludge management plan shall apply to all application sites, regardless of size or frequency of application. However, the requirements relative to monitoring, reporting, and recording of site specific soils and the monitoring, reporting, and recording of ground water and surface water are not applicable for any site that meets criteria established in the Biosolids Use Regulations (12 VAC 5-585) for a monitoring waiver.

Article 2.
Operation and Maintenance Manuals.

9 VAC 25-790-290. Manuals.

A. General. The general purpose of the manual is to present both technical guidance and regulatory requirements to facilitate operation and maintenance of the sewerage systems and treatment works for both normal conditions and generally anticipated adverse conditions. The manual should be designed as a reference document, being as brief as possible while presenting the information in a readily accessible manner. The manual shall be tailored to the size and type of system being employed. The manual shall be directed toward the operating staff required for the facility as listed in Table 1. The manual shall be updated as necessary and be made available to the operating staff.

B. Contents. The manual shall contain the elements included in 9 VAC 25-790-260 B; 9 VAC 25-790-270 B; 9 VAC 25-790-280 B; subsection A of this section; and 9 VAC 25-790-300 B, C and D. In addition, the manual should contain, for information and guidance purposes, additional schedules that supplement these required schedules to assist operations by defining desired levels of staffing, testing, etc. Suggested contents are contained in 9 VAC 25-790-950 and 9 VAC 25-790-960.

Article 3.
Requirements for Sewerage Systems and Treatment Works Reliability.

9 VAC 25-790-300. Reliability.

A. Additional operation and maintenance documentation may be necessary where performance reliability has not been established or worker safety and public health protection is questioned.

B. Operability. Independently operated essential equipment or components of sewerage systems and treatment works shall be provided with sufficient duplication or alternative operation so that the average daily design flow may be transported, stored, treated or otherwise managed in accordance with reliability requirements with the largest component out of service. Sufficient spare parts to ensure continuous operability of essential unit operations and equipment shall be kept in a central storeroom located at the treatment works or at other readily accessible locations, and the minimum quantities shall be in accordance with the operation and maintenance manual. The need for spare parts should be determined from review of manufacturer's recommendations, evaluation of past maintenance requirements, etc. A spare parts inventory shall be included in the operation and maintenance manual. The inventory shall list the minimum and maximum quantities of the spare parts to be kept on hand, the equipment in which they are used, their storage location, replacement procedures and other pertinent information. A suggested spare parts inventory system is contained in Part IV (9 VAC 25-790-940 et seq.) of this chapter.

C. Maintenance. A regular program of preventive maintenance shall be adhered to. The Operations and Maintenance Manual shall contain a system of maintenance requirements to be accomplished.

1. A minimum preventive maintenance system shall be provided in accordance with the Operations and Maintenance Manual. Such a system should provide for advanced scheduling of preventive maintenance and should be continually assessed in order to reflect increased service requirements as equipment ages or flow rates increase.

2. Adequate records, files and inventories to assist the operator in his task should also be maintained.

3. A schedule for testing the integrity of all auxiliary standby power equipment, portable pumps, automatic electrical switchover gear, and diversion piping should be developed and adhered to on a regular basis. A suggested maintenance system is outlined in this chapter. In cases where certain components of the treatment process may be damaged by flooding from natural events in such a manner as to cause excessive delays in restoring the treatment process to the design operating level, the means of removal of such components prior to flooding should be described in the Operational and Maintenance Manual.

D. Personnel. The recommended attendance hours by a licensed operator and the minimum daily hours that the treatment works should be manned by operating staff are contained in Table 1. The number of operating staff provided daily at a treatment works depends upon these requirements, as well as upon the permit compliance status and the operational conditions, such as:

1. The design capacity (flow);

2. The quality of the effluent;

3. The complexity of the treatment processes used; and

4. The fact that only a licensed operator may be specified as the individual in charge of overseeing permit compliance.

In instances where the recommended hours of attendance by a licensed operator are less than the daily hours the treatment works is to be manned by operating staff (see Table 1), a licensed operator is not required to be physically located at the treatment works site during the remaining designated manning hours, provided that the licensed operator is able to respond to requests for assistance in a satisfactory manner, as described in the Operation and Maintenance Manual.

E. Conditions. The objective of treatment works operation should be to provide the most reliable and efficient performance that can be practically achieved in compliance with permit requirements, while providing for safe working conditions. Operational health and safety provisions are critical. Cross media pollution prevention measures should be evaluated and developed where practical, and material safety data sheets for toxic chemicals used should be readily available.

1. Alternate operating provisions shall be utilized as necessary in accordance with the reliability classification. An all-weather road shall be provided to permit access to and from the treatment works during normal weather conditions. Escape routes and methods should be established for emergency situations.

2. Pretreatment requirements as set forth in the State Water Control Board's Regulations should be established and monitored in accordance with local regulations specific to such requirements.

3. Local standards and specifications approved in accordance with this chapter shall provide for the construction methods, as necessary in accordance with the local owner's sewer line maintenance program, to minimize excessive amounts of infiltration and inflow and prevent the accumulation of solids or debris that would interfere with the transmission of flow resulting in overflows, bypassing, or offline flow surcharges such as in service connections.

4. Odor control measures should be established in accordance with site specific features and weather patterns. Development of objectionable odors shall be addressed by the best available odor control technology.

TABLE 1.
CLASSIFICATION OF TREATMENT WORKS AND RECOMMENDED MINIMUM HOURS OF ATTENDANCE BY LICENSED OPERATORS AND OPERATING STAFF [1].

Treatment Works Classification & Treatment Required Classification of the Operator in responsible charge	Treatment Works Capacity (MGD)	Treatment Process Methods	Recommended Attendance by a Licensed Operator [2,3] Time-Hrs.	Recommended Daily Hours That Works Should Be Manned [2,3]
I	Greater than 10 MGD	Biological Treatment Methods		
		(A) Suspended Growth Reactors	24	24
		(B) Aerated Lagoons or Constructed Wetlands	16	24
		(C) Filters or Other Attached Growth Contactors	24	24
		(D) Processes Utilizing Biological Nutrient Control	24	24
		(E) Processes Utilizing Land Treatment	During Land Application	- -
I	Equal to or less than 10 MGD but greater than 5 MGD	Biological Treatment Methods		
		(A) Suspended Growth Reactors	16	24
		(B) Aerated Lagoons or Constructed Wetlands	8	16
		(C) Filters or Other Attached Growth Contactors	16	24
		(D) Processes Utilizing Biological Nutrient Control	16	24
		(E) Processes Utilizing Land Treatment	During Land Application	- -
I	Greater than 5 MGD	Advanced Waste Treatment (AWT)		
		(A) Ammonia Stripping	24	24
		(B) Breakpoint Chlorination	24	24
		(C) Carbon Adsorption	24	24
		(D) Chemical Coagulation, Flocculation, Precipitation	24	24
		(E) Filtration	24	24
		(F) Demineralization (Ion Exchange, Reverse Osmosis, Electrodialysis)	24`	24
I	Equal to or less than 5 MGD but greater than 2.5 MGD	Advanced Waste Treatment		
		(A) Ammonia Stripping	16	24
		(B) Breakpoint Chlorination	16	24
		(C) Carbon Adsorption	16	24
		(D) Chemical Coagulation, Flocculation, Precipitation	16	24
		(E) Filtration	16	24
		(F) Demineralization (Ion Exchange, Reverse Osmosis, Electrodialysis)	16	24
		(G) Microstraining/Screening	16	24
II	Greater than 2.5 MGD but equal to or less than 5.0 MGD	Biological Treatment Methods		
		(A) Suspended Growth Reactors	8	24
		(B) Aerated Lagoons or Constructed Wetlands	8	26
		(C) Filters or Other Attached Growth Contactors	8	24
		(D) Processes Utilizing Biological Nutrient Control	8	24
		(E) Processes Utilizing Land Treatment	During Land Application	- -

II	Greater than 0.5 MGD but equal to or less than 2.5 MGD	Biological Treatment Methods (A) Suspended Growth Reactors (B) Aerated Lagoons (C) Filters or Other Attached Growth Contactors (D) Processes Utilizing Biological Nutrient Control (E) Processes Utilizing Land Treatment	 8 4 8 8 During Land Application	 16 8 16 16 - -
II	Greater than 0.1 MGD but equal to or less than 2.5 MGD	Advanced Waste Treatment (A) Ammonia Stripping (B) Breakpoint Chlorination (C) Carbon Adsorption (D) Chemical Coagulation, Flocculation, Precipitation (E) Filtration (F) Demineralization (Ion Exchange, Reverse Osmosis, Electrodialysis)	 8 8 8 8 8 8	 16 16 16 16 16 16
III	Greater than 0.04 MGD but Equal to or less than 0.5 MGD	Biological Treatment Methods (A) Suspended Growth Reactors (B) Aerated Lagoons or Constructed Wetlands (C) Filters or Other Attached Growth Contractors (D) Processes Utilizing Biological Nutrient Control (E) Processes Utilizing Land Treatment	 8 8 8 8 During Land Application	 8 8 8 8 - -
III	Greater than 1.00 MGD	Natural Treatment Methods	4	8
III	Greater than 0.001 MGD but equal to or less than 0.1 MGD	Advanced Waste Treatment (A) Ammonia Stripping (B) Breakpoint Chlorination (C) Carbon Adsorption (D) Chemical Coagulation, Flocculation, Precipitation (E) Filtration (F) Demineralization (Ion Exchange, Reverse Osmosis, Electrodialysis)	 8 8 8 8 8 8	 8 8 8 8 8 8
IV	Greater than 0.001 MGD but equal to or less than 0.04 MGD	Biological Mechanical Methods (4)	4 (5)	4 (5)
IV	Greater than 0.001 MGD but equal to or less than 1.00 MGD	Natural Treatment Methods (4)	4 (5)	4 (5)

Notes:

(1) Specific requirements for the number of licensed operators and the number and qualifications of the operating staff specified in accordance with this chapter and in consultation with and concurrence by the director are to be evaluated on a case-by-case basis in accordance with operational reliability and permit compliance data. Such requirements are to be included in the Operation and Maintenance Manual.

(2) If a particular treatment unit or units are discontinued or not in use for a significant period of time and the remaining treatment processes result in a lower classification for the treatment works, the licensed operator and operating staff requirements during that period may be reduced to that required for the type and classification of treatment process remaining in service, after concurrence by the director.

(3) If more than one sewage treatment process is used, the more stringent requirements among the processes will apply. In some cases, complexity of operation for several AWT processes in sequence may require more than the minimum coverage.

(4) Mechanical treatment processes are defined as those containing aerated and mixed flows using electrical or outside energy sources.

(5) An operator is not required unless the facility is designated as a wastewater treatment works by DEQ.

PART III.
MANUAL OF PRACTICE FOR SEWERAGE SYSTEMS AND TREATMENT WORKS.

Article 1.
Collection and Conveyance Sewers.

9 VAC 25-790-310. Design factors.

A. Sewage collection systems shall be designed and constructed to achieve total containment of the predicted sewage flows contributed from the established service area and population. New combined sewers receiving direct storm water drainage shall not be approved. Interceptor sewers for existing combined sewers shall be designed and constructed to prevent the discharge of inadequately treated wastes. Overflows from intercepting sewers shall be managed in accordance with the issued certificate or permit.

B. Basis. In general, sewer systems should be designed for the estimated ultimate tributary population with an upper limit consisting of the 50-year population growth projection, except when considering parts of the systems that can be readily increased in capacity. Consideration shall be given to land use plans and to other planning documents and to the maximum anticipated capacity of institutions, industrial parks, apartment developments, etc.

C. Factors. In determining the required capacities of sanitary sewers, the following factors shall be considered:

a. Maximum hourly sewage flow.

b. Additional maximum sewage or wastewater flows from industrial sources.

c. Ground water infiltration.

d. Topography of area.

e. Location of sewage treatment works.

f. Depth of excavation.

g. Pumping requirements.

h. Occupancy rates.

D. Capacity. New sewer system capacity shall be designed on the basis of an average daily per capita flow of sewage of not less than that set forth in Table 3 (9 VAC 25-790-460) of this chapter. These figures are assumed to include infiltration but do not address inflow. When deviations from the foregoing per capita rates and established peak flow factors are proposed, a description of the procedure used to establish those design flows shall be included with the submission for the purpose of this chapter, the following list defines the various collection system components that are to be designed to transmit peak flow rates:

1. "Lateral" means a sewer that has no other common sewers discharging into it.

2. "Submain" means a sewer that receives flow from one or more lateral sewers.

3. "Main or trunk" means a sewer that receives sewage flow from one or more submain sewers.

4. "Interceptor" means a sewer that receives sewage flow from a number of gravity mains, trunk sewers, sewage force mains, etc.

The minimum peak design capacity for lateral and submain sewers should be 400% of the average design flow.

Minimum peak design capacity of main, and trunk, sewers should be 250% of the average design flow.

Minimum peak design for interceptor sewers shall be 200% of the average design flow.

9 VAC 25-790-320. Design details.

A. Sizing. For the purpose of this chapter the gravity sewer design details as described herein represent the best available standards of practice. Hydraulic computations and other design data should clearly establish the capacity of proposed sewers that do not conform to the minimum standards included in this section.

1. Sewer size shall not be less than eight inches in diameter, except under the following conditions:

a. Laterals serving six connections or fewer on cul de sacs or as sidewalk collector lines may be six inches in diameter.

b. Sewer lines carrying settled sewage, such as septic tank effluent, may be as small as 1-1/2 inches in diameter.

2. Engineering calculations and justifications indicating that reduced line sizes are adequate shall be included with the submission.

B. Placement. Gravity sewers shall be of suitable material and placed such that their design capacity is maintained and leakage into and out of the pipelines is within allowable values.

1. Sewers shall be installed at a sufficient depth to prevent ice formation due to cooling of the wastewater flows, resulting in blockage of the flow channel. Sewers carrying nonsettled sewage and sewers carrying settled sewage shall be designed and constructed to give mean velocities, when flowing full, of not less than two feet per second and 1.3 feet per second, respectively, based on Manning's formula using a pipe material roughness coefficient ("n") value of 0.014. Use of other "n" values and slopes less than those specified herein shall be justified on the basis of pipe material specifications, research, or field data, presented with the submission for approval.

2. The following list represents the minimum slopes, which should be provided for gravity sewers; however, slopes greater than those listed are desirable:

Sewer Size	Minimum Slope in Feet per 100 Feet	
	Nonsettled Sewage	Settled Sewage
3 inch	Not Allowed	0.53
4 inch	Not Allowed	0.47
6 inch	0.49	0.21
8 inch	0.40	0.15
10 inch	0.28	0.12
12 inch	0.22	0.086
14 inch	0.17	0.068
15 inch	0.15	0.063
16 inch	0.14	0.058
18 inch	0.12	0.050
21 inch	0.10	0.040
24 inch	0.08	0.034
27 inch	0.067	0.029
30 inch	0.058	0.025
36 inch	0.046	0.020

3. Decreased slopes may be provided where the depth of flow will be 0.3 of the diameter or greater for design average flow. Whenever such decreased slopes are selected, design consultants must furnish, with their report, computations of the depth of flow in such pipes at minimum, average, and peak daily or hourly rates of flow. Otherwise, it must be recognized that decreased slopes may require available resources for additional sewer maintenance.

4. Sewers shall be installed with uniform slope between manholes.

5. Sewers constructed on 20% slope or greater shall be anchored securely with concrete anchors or equal. Suggested minimum anchorage is as follows:

a. Not over 36 feet center-to-center on grades 20% and up to 35%.

b. Not over 24 feet center-to-center on grades 35% and up to 50%.

c. Not over 16 feet center-to-center on grades 50% and over.

6. Gravity sewers shall normally be installed with a straight alignment between manholes. Curved sewers should be installed only on curved streets, where the curve of the street and the curve of the sewer are concentric. The use of curved alignment for sewers may be considered, with the following restrictions:

a. Justification shall be provided by the design consultant to verify that the curved alignment is more advantageous for that installation.

b. The use of curved sewers shall be limited to conveyance of settled sewage unless the owners can document that the specialized equipment necessary to clean the sewers will be obtained and used as necessary.

c. The minimum radius of the curve shall be based on the maximum allowable joint deflection in accordance with the appropriate ASTM standard or other appropriate standard.

d. The sewers shall be installed with smooth radius curves.

7. Gravity sewer size shall normally remain constant between manholes. Where a smaller sewer joins a larger one, the relative elevations of the inverts of the sewers shall be arranged to maintain approximately the same energy gradient. An approximate method for securing these results, which may be used, is to align the 80% capacity flow level, or to align the internal pipe crown or top invert, of both sewers, at the same elevation.

8. Where velocities greater than 15 feet per second are expected, special provisions shall be made to protect against internal erosion by high velocity. The pipe shall conform to applicable ASTM, AWWA, ANSI, or other appropriate standards or specifications, which provide protection against internal erosion.

9. Any generally accepted material for sewers will be given consideration, but the material selected shall be adapted to local conditions such as character of industrial waste, possibility of septicity, soil characteristics, exceptionally heavy internal-external loadings, abrasions, and similar problems. The pipe material shall conform to applicable ASTM, AWWA, ANSI, or other appropriate standards and the pipe is to be marked with an approved identification such as the specifications standard.

10. All sewers shall be designed to prevent damage from superimposed loads. Proper allowance shall be made for loads on the sewer as a result of the width and depth of the trench.

9 VAC 25-790-330. Construction details.

A. Pipe joints. The method of joining pipe and the material used shall be included in the design specifications in accordance with ASTM or other nationally recognized standards and the joint material and joint testing shall conform to the appropriate standards and specifications.

1. Sewer joints shall be designed to prevent infiltration and to prevent the entrance of roots.

2. When clay sewer pipe is used, the joints shall be compression joints, made in conformance with the appropriate ASTM specification.

3. When concrete pipe is used, single rubber ring gasket joints shall conform to the appropriate ASTM specification.

4. When asbestos cement pipe, truss pipe, or ductile iron pipe is used, joints using couplings and gaskets shall be made in conformance with the requirements of the appropriate ASTM specification.

5. Joints for plastic material pipe may be of compression gaskets, chemical welded sleeves, or chemical fusion joints per manufacturers' recommendations.

Heat fusion joints may be used for high density polyethylene pipe.

B. Leakage. An acceptance test shall be specified for all gravity sewer lines. The test may be either a hydrostatic test or an air test.

1. Where hydrostatic testing is specified (infiltration or exfiltration), the leakage outward or inward shall not exceed 100 gallons per inch of nominal pipe diameter per mile per day (2,400 gpd/mi maximum) for any section of the system. Manholes should be tested prior to pipeline testing. Where the exfiltration test is employed, the line shall be subjected to a minimum of four feet of head, or up to the head to the top of the previously tested manhole, whichever is the lesser, above the crown of the pipe at the upstream manhole of the section being tested.

2. The infiltration test shall be allowed only when it can be shown that the hydrostatic head outside the pipe is a minimum of four feet or exceeds the upstream manhole depth, whichever is the lesser, above the crown of the pipe for the entire length of the pipe being tested.

3. Where air testing is specified, test methods and acceptability criteria shall be in accordance with the appropriate ASTM specification. Air testing shall generally be acceptable for all types of pipe materials. If air testing is employed, the manholes shall be tested by exfiltration.

4. Manhole leaking standards as specified in 9 VAC 25-790-350 shall be obtained.

C. Building sewers. Sewerage service lines from buildings (sewers) shall be constructed in accordance with either the Uniform Statewide Building Code of Virginia or this chapter and standards contained in this chapter, depending on jurisdictional considerations as outlined in Part IV (9 VAC 25-790-940 et seq.) of this chapter. An interceptor, or separation basins, may be required under the provisions of state or local building codes or standards and the provisions of this chapter.

1. Connections shall be made to sewers by replacing a length of pipe with branch fittings, or a clean opening cut with tapping equipment and a "y" type of connection completed and sealed. In some instances a tee-saddle or tee-insert may be attached to the sewer submain to provide a connection.

2. All connections to sewers and manholes shall be made so as to prevent structural damage and infiltration. To meet future needs, stubs, wyes, and tees may be installed if plugged tightly.

D. Trench construction. Class A, B, or C bedding (American Society of Civil Engineers (ASCE) Manuals and Reports on Engineering Practice--No. 36, 1974, Water Pollution Control Federation (WPCF) Manual of Practice--No. 9, 1970, and American Waterworks Association (AWWA) for Installation of Ductile-Iron Water Mains and their Appurtenances (ANSI/AWWA C600-82), 1982, bedding class shall be provided for rigid pipe, and appropriate installation shall be provided for flexible pipe material in accordance with recognized standards and manufacturers' recommendations.

1. Trenches shall be carefully backfilled with excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand and gravel, soft shale, or other approved materials free from large clods of earth or stones larger than one inch in diameter, deposited in six inch layers, and thoroughly and carefully tamped until the pipe has a cover of not less than one foot.

2. The remainder of the backfill shall be placed in the trench in layers not exceeding two feet and thoroughly tamped. No stone or rock larger than five inches in its greatest dimension shall be used in backfilling.

3. Trenches in public roadways shall be excavated, backfilled and compacted in accordance with the standards specified in the Virginia Department of Transportation's Road and Bridge Specifications or other acceptable criteria.

9 VAC 25-790-340. Vacuum sewage system.

A. Features. Vacuum sewer systems consisting of small diameter pipes that collect sewage delivered through multiple service connection values and deliver that flow under negative pressure to one or more receiving stations will be considered on a case-by-case basis. The design shall include, but not be limited to, the following criteria:

1. Minimum pipe diameter shall be three inches for nonsettled sewage and 1-1/2 inches for settled sewage.

2. Shut-off valves shall be provided at branch connections with lines exceeding 300 feet and at intervals no greater than 2000 feet on main vacuum lines. Valves shall not obstruct the flow path when fully opened for operation. Gate valves and butterfly valves may not be acceptable if the flow path is obstructed during system operation.

3. Access points equal to the vacuum line diameter shall be provided at the end of main and branch lines and at intervals or locations suitable for operation and maintenance of the system. Access or inspection points shall be provided so that a suitable means for shut off of lines can be readily inserted.

4. Provisions for vacuum testing the piping system shall be described and made available to the department.

B. Connection valves. The minimum diameter of vacuum valves for nonsettled sewage shall be such that a sphere of 2-1/2 inches can pass through. For settled sewage a 1-1/2 inches sphere shall pass through the vacuum valve. Vacuum valves shall be capable of operation under severe climatic conditions such as submerged under water or ice conditions. Air vents shall extend above ground to a level up to the 100-year flood elevation, if practical. Air vent design should provide protection against both freezing and physical damage, where possible. Access to valve pits shall be such that valves may be easily removed and replaced. A holding tank of sufficient volume up to 25% or more of the design daily flow shall be provided upstream of the vacuum valve when the location of the vacuum valve alone does not permit proper system operation.

C. Receiving station. A minimum of two sewage and vacuum pumping units shall be provided for receiving stations. The system shall be capable of handling peak sewage and air flow conditions with one unit out of service. In the overall design, consideration shall be given to pump cooling requirements and features required for pumping moist air containing sewer gases. Provisions for odor control such as exhaust air oxidation or deodorization shall be considered in the system design. The design of the pump station should minimize the discharge of air along with the sewage. The capacity of the collecting tanks shall be sufficient to limit the start frequency of all pumps to less than 12 per hour. The number of collection tanks shall be established to account for system reliability and operability.

1. Provisions shall be made to isolate the receiving vacuum collection tank, vacuum pumps, raw sewage influent line, and raw sewage discharge pumps.

2. The raw sewage pumps shall meet all applicable requirements of this chapter. The negative head created by the vacuum pumps shall be considered in calculating Net Positive Suction Head (NPSH).

D. Service. Adequate service arrangements shall be provided for routine and emergency maintenance and operation. The arrangements shall include:

1. Right of access.

2. Adequate spare valves, spare parts, and service tools.

3. Monitoring, alarm system to locate vacuum loss or valve failure.

E. Operability. The vacuum collection system is to be operated in a manner to prevent the discharge of raw sewage to any waters and to protect public health and welfare by preventing back-up of sewage and subsequent discharge to basements, streets, and other public and private property.

1. Provisions for maintaining interim household service and preventing sewage overflows during system malfunction shall be described and submitted with design information in accordance with this chapter.

2. An alarm system shall be provided capable of alerting maintenance personnel of operational and safety problems in case of malfunction in the collection system.

9 VAC 25-790-350. Manholes.

A. Location. Manholes shall be installed at the end of each line of eight-inch diameter or greater; at all changes in grade, size, or alignment; at all intersections; and at distances not greater than 400 feet for sewers 15 inches or less in diameter and 500 feet for sewers 18 inches to 30 inches in diameter, except that distances up to 600 feet may be adequate in cases where adequate modern cleaning equipment for such spacing is provided.

1. Slightly greater spacing may be utilized in larger sewers.

2. Terminal cleanouts may be acceptable in place of manholes, on lines eight inches in diameter or less, on a case-by-case basis. Cleanouts may be used in lieu of manholes for collection of settled sewage. Manholes are required where four or more sewers intersect, or where two or more sewers intersect at depths greater than eight feet. Cleanouts shall be installed at distances not greater than 400 feet for settled sewage systems.

B. Materials. Manholes shall be constructed of materials that will maintain structural integrity throughout the design life of the sewer. Manhole wall and bottom construction shall be such as to ensure water tightness and the Virginia Department of Labor and Industry, Occupational Safety and Health Administration (VOSH) requirements may also specify design requirements. Confined space entry restrictions are to be met. For those manholes and vertical sections of pipe tees used for maintenance access, safety slabs or platform benches should be provided at depth intervals of 10 feet or less as required unless adequate access lifting devices are provided in accordance with VOSH or other recognized standards. The use of sections of reinforcing bars as access steps is not recommended for safety considerations.

C. Features. The base inside diameter of manholes and vertical pipe tees used for maintenance access shall be a minimum of 42 inches. The clear opening in the manhole frame shall be a minimum of 24 inches. Larger base diameters are preferred.

1. The manhole foundation shall be adequately designed to support the manhole and any superimposed loads that may occur.

2. The flow channel through manholes shall be of such shape and slope to provide smooth transition between inlet and outlet sewers and to reduce turbulence. Benches shall be sloped to the channel to prevent accumulation of solids.

3. When the flow direction or horizontal deflection of a sewer line varies significantly, elevation changes may be necessary to provide for head losses. The minimum vertical change in elevation from upstream to downstream should provide for a head loss of up to 3 inches or more, when ninety degrees of deflection is specified.

4. Watertight manhole covers or watertight manhole inserts shall be used whenever the manhole tops may be flooded for several hours or more. As a minimum, watertight manhole covers or watertight manhole inserts shall be used when the manhole top is below the elevation of the 100-year flood/wave action.

5. Masonry manholes of brick or segmented block and the nongasketed joints of precast manholes shall be waterproofed on the exterior with suitable coatings (e.g., cement supplemented with bituminous).

6. Inlet and outlet pipes shall be joined to the manhole with a gasketed flexible watertight connection or any watertight connection arrangement that allows differential settlement of the pipe and manhole wall to take place without destroying the watertight integrity of the line connections.

7. Ventilation of gravity sewer systems shall be provided where continuous watertight sections greater than 1,000 feet in length are incurred.

8. In accordance with this chapter and standards contained in this chapter, frames, and covers shall be of suitable material and designed to accommodate prevailing site conditions. Ventilation, safety lines, hoist arrangements and other requirements, as necessary for material maintenance access, should be provided in accordance with VOSH requirements.

9. A drop pipe should be provided for an upstream sewer entering a manhole at an elevation of 24 inches or more above the manhole invert unless sewer pipe crowns match elevations, or as may otherwise be required to conform to the use of standard fittings in the drop pipe construction. Where the difference in elevation between the incoming sewer and the manhole invert is less than 24 inches, the invert shall be filleted to prevent solids deposition. A drop pipe shall be used when the upstream to downstream invert difference exceeds 24 inches and the sewer deflects horizontally at a manhole. The drop through the manhole should be a maximum of four inches for a 90° horizontal deflection.

D. Leakage testing. Manholes may be tested for leakage at the same time that gravity sewer lines are being hydrostatically tested for leakage. For manholes greater than four feet in depth whose entire depth was not included in the hydrostatic testing of the sewer line, the manholes shall be tested by exfiltration. Inflatable stoppers shall be used to plug all lines into and out of the manhole being tested. The manhole shall be filled with water to the top of the rim. A maximum 12-hour soak shall be allowed. Leakage shall not exceed 0.25 gallon per hour (gph) per foot of depth.

1. If air testing of sewer lines is employed, the manholes shall normally be tested by exfiltration. Inflatable stoppers shall be used to plug all lines into and out of the manhole being tested. The stoppers shall be positioned in the lines far enough from the manhole to ensure testing of the untested portions of the lines. The manhole shall then be filled with water to the top of the rim. A maximum 12-hour soak shall be allowed. Leakage shall not exceed 0.25 gph per foot.

2. Air testing or vacuum testing of manholes for leakage may be considered on a case-by-case basis. It is important that the entire manhole from the invert to the top of the rim be tested.

9 VAC 25-790-360. Water quality and public health and welfare protection.

A. Design integrity. The tops of all sewers entering or crossing streams shall be at a sufficient depth below the natural bottom of the streambed to protect the sewer line. In general, one foot of suitable cover shall be provided where the stream is located in rock and three feet of suitable cover in other material. Less cover will be considered if the proposed sewer crossing is encased in concrete and will not interfere with future improvements to the stream channel. Reasons for requesting less cover shall be given in the application. Below paved channels, the crown of the sewer lines should be placed under the channel pavement. Sewers shall remain fully operational during the 25-year flood/wave action. Sewers and their appurtenances located along streams shall be protected against the normal range of high and low water conditions, including the 100-year flood/wave action. Sewers located along streams shall be located outside of the streambed wherever possible and should be sufficiently removed therefrom to provide for future possible channel widening. Reasons for requesting sewer lines to be located within streambeds shall be given in the application.

1. Sewers entering or crossing streams shall be constructed of watertight pipe. The pipe and joints shall be tested in place and shall exhibit zero infiltration. Sewers laid on piers across ravines or streams shall be allowed only when it can be demonstrated that no other practical alternative exists. Such sewers on piers shall be constructed in accordance with the requirements for sewers entering or crossing under streams. Construction methods and materials of construction shall be such that sewers will remain watertight and free from change in alignment or grade due to anticipated hydraulic and physical loads, erosion, and impact.

2. Depressed sewers or siphons shall have not less than two barrels, with a minimum pipe size of six inches and shall be provided with necessary appurtenances for convenient flushing and maintenance; the inlet and outlet chambers shall be designed to facilitate cleaning; and, in general, sufficient head shall be provided and pipe sizes selected to secure velocities of at least three feet per second for average flows. The inlet and outlet details shall be arranged so that normal flow is diverted to one barrel and so that either barrel may be removed for service or cleaning.

B. Water supplies. No general requirement can be made to cover all conditions. Sewers shall meet the requirements of the appropriate reviewing agency with respect to minimum distances to structures and pipelines utilized for drinking water supplies. There shall be no cross connection between a drinking water supply and a sewer, or appurtenance thereto.

1. The requirements of the Virginia Waterworks Regulations (12 VAC 5-590) shall be satisfied.

2. The requirements of the Virginia Sewage Handling and Disposal Regulations (12 VAC 5-610) shall be satisfied.

3. No sewer line shall pass within 50 feet of a drinking water supply well, source, or structure unless special construction and pipe materials are used to obtain adequate protection. The proposed design shall identify and adequately address the protection of all drinking water supply wells, sources, and structures up to a distance of 100 feet of the sewer line installation.

4. Sewers shall be laid at least 10 feet horizontally from a water main. The distance shall be measured edge-to-edge. When local conditions prohibit this horizontal separation, the sewer may be laid closer provided that the water main is in a separate trench or an undisturbed earth shelf located on one side of the sewer and the bottom of the water main is at least 18 inches above the top of the sewer. Where this vertical separation cannot be obtained, the sewer shall

be constructed of water pipe material in accordance with AWWA specifications and pressure tested in place without leakage prior to backfilling. The hydrostatic test shall be conducted in accordance with the most recent edition of the AWWA standard (ANSI/AWWA C600-82) for the pipe material, with a minimum test pressure of 30 psi.

5. Sewers shall cross under water mains such that the top of the sewer is at least 18 inches below the bottom of the water main. When local conditions prohibit this vertical separation, the sewer shall be constructed of AWWA specified water pipe and pressure tested in place without leakage prior to backfilling, in accordance with the provisions of this chapter. Sewers crossing over water mains shall:

a. Be laid to provide a separation of at least 18 inches between the bottom of the sewer and the top of the water main.

b. Be constructed of AWWA approved water pipe and pressure tested in place without leakage prior to backfilling, in accordance with the provisions of this chapter.

c. Have adequate structural support to prevent damage to the water main.

d. Have the sewer joints placed equidistant and as far as possible from the water main joints.

6. No water pipe shall pass through or come into contact with any part of a sewer manhole. Manholes shall be placed at least 10 feet horizontally from a water main whenever possible. The distance shall be measured edge-to-edge of the pipes or structures. When local conditions prohibit this horizontal separation, the manhole shall be of watertight construction and tested in place.

9 VAC 25-790-370. System access.

Sewer location should be within streets, alleys, and utility rights-of-way. Approvals shall be obtained from the appropriate jurisdictions for placement of sewers within these boundaries.

Where it is impossible to avoid placing sewers (and manholes/cleanouts) on private property, the owner shall have recorded easements or have filed certificates of condemnation from all parties possessing or having legal interest in an adequate right-of-way necessary for proper installation, maintenance, operation, and removal of sewerage facilities. These easements shall include provisions for controlling the location of fences, buildings, or other structures within the easement and shall be shown on the plans.

Article 2.
Sewage Pump Stations.

9 VAC 25-790-380. Sewage pumping.

A. Features. Sewage pump stations should be located as far as practicable from present or proposed built-up residential areas, and an all-weather road shall be provided. Stations should have a proper zone of controlled or limited use surrounding them. Within such zones, residential uses or high density human activities or activities involving food preparation should be prevented. Provisions for noise control and odor control, and station architectural design should conform to site requirements. Sites for stations shall be of sufficient size for future expansion or addition, if applicable. All mechanical and electrical equipment which could be damaged or inactivated by contact with or submergence in water (motors, control equipment, blowers, switch gear, bearings, etc.) shall be physically located above the 100-year flood/wave action or otherwise protected against the 100-year flood/wave action damage. All stations shall be designed to remain fully operational during the 25-year flood/wave action.

1. Where it may be necessary to pump raw (untreated) or unsettled sewage prior to grit removal, the design of the wet well shall receive special attention. The discharge piping shall be designed to prevent grit settling in the discharge lines when pumps are not operating.

2. At least two pumping units shall be provided. Where two units are provided, each shall be capable of handling flows in excess of the expected maximum flow or a minimum of 2-1/2 times the average design flow, whichever is greater. Where three or more units are provided, they shall be designed to fit actual flow conditions and must be of such capacity that, with any one unit out of service, the remaining units will have capacity to handle the maximum sewage flow or a minimum of 2-1/2 times the average design flow, whichever is greater. When the station is expected to operate at a flow rate less than one-half times the average design flow for an extended period of time, the design shall address measures taken to prevent septicity due to long holding times of untreated sewage in the wet well.

3. Treatment works pump stations should be designed so that sewage will be delivered to the treatment works at approximately the same rate it is received at the pump station. At least two pumping units shall be provided. Treatment works pump stations are those stations which discharge to sewage treatment works without dissipation of flow through a gravity collection system. Where only two pumping units are to be utilized, they shall be variable speeded and sized so that the pumps deliver from 1/2 to 2-1/2 times the average design flow or the maximum flow, whichever is greater, except where flow equalization is utilized in accordance with this chapter. Where constant

speed pumps are to be utilized without equalization, either (i) at least three pumps, each having a capacity of approximately 1-1/4 times the average design flow, or (ii) two pumps, each having a capacity of approximately 1-1/4 times the average design flow, with the third pump having a capacity of 2-1/2 times the average design flow, shall be provided as needed to transfer the maximum flow. Multiple-speed pumps in lieu of variable speed pumps may be considered for specific applications. These criteria for influent flows will not apply to such treatment works where several days' holding capacity is provided, such as in stabilization ponds or in aerated lagoons.

4. Pumps handling raw sewage should be preceded by readily accessible bar racks with clear openings not exceeding 2-1/2 inches, unless pneumatic ejectors are used or special devices are installed to protect the pumps from clogging or damage. Where the size of the installation warrants, a mechanically cleaned bar screen with either a grinder or comminution device is recommended. Where screens are located below ground, convenient facilities must be provided for handling screenings. For the larger or deeper stations, duplicate protection units of proper capacity are preferred. Interceptor or separation basins may be necessary prior to pumps handling raw sewage.

5. Pumps in which the solids pass through the impeller(s) shall be capable of passing spheres of at least three inches in diameter. Pumping equipment having integral screens for preventing solids from passing through the impeller shall be capable of passing spheres of at least two inches in diameter. Pumping equipment preceded by grinding equipment shall be capable of passing the solids discharged from the grinding mechanism.

6. Pumps shall be so placed that under normal start conditions they will start with a positive suction head, except as specified for suction lift pumps. Each pump shall have an individual intake and suction line. Wet well design should be such as to avoid turbulence near the intake. Pump suction and discharge piping shall not be less than four inches in diameter except where design of special equipment allows. The design velocity in pump piping should not exceed (i) six feet per second in the suction piping, and (ii) in the discharge piping, eight feet per second. All pumps should be provided with an air relief line on the pump discharge piping.

7. Control float cages shall be so located as not to be affected by the flows entering the wet well or by the suction of the pumps. Float tubes will not be permitted in either the wet or dry well. Air-operated pneumatic controls are preferred for all sewage pump stations. Provisions shall be made to automatically alternate the pumps in use (which is referred to as lead-lag operation) unless adequate operation and maintenance is to be provided to protect against pump failure.

8. For the purpose of designating liquid levels for alarm requirements, high liquid level in the wet well is defined as a level of sewage in the wet well above normal operating levels such that either: (i) a backup of sewage in the incoming sewer may occur, or (ii) an overflow may occur, or (iii) standby pump(s) may be required to be activated. In the case of a duplex pump station with limited wet well volume, the alarm design should include activation at the time of simultaneous operation of both pumps, initiating when the second alternating pump starts (referred to as the lag pump).

9. Suitable shut-off valves shall be placed on each suction and each discharge line of each pump for normal pump isolation. A check valve is to be placed on each discharge line, between the shut-off valve and the pump. No shut-off valve need be placed on the suction side of suction lift or submersible pumps. Periodic exercising of valves should be specified within the routine maintenance programs.

10. System pump stations should have the provision for installing flow measuring devices when necessary. Consideration should be given to installation of such devices in system pump stations whose flow rate can affect the proper operation of the treatment works.

11. Adequate lighting for the entire pump station shall be provided in accordance with VOSH and other applicable codes and standards.

12. Pump stations shall be designed in accordance with the statewide building code and so as to minimize the adverse effects of vandalism. Pump stations shall be equipped with a secure external disconnect switch located above grade where possible.

B. Ventilation shall be provided in accordance with VOSH requirements and shall comply with this chapter for enclosed spaces within pump stations during all periods when the station is manned. Where the pump is permanently mounted below the ground, mechanical ventilation is required and shall be arranged so as to independently ventilate the dry well.

1. As a minimum, ventilation of the wet well shall be accomplished by the provision of a properly screened vent, with the end either turned downward or provided with a "mushroom" cap. The vent shall be at least four inches in diameter. If screens or mechanical equipment, which might require periodic maintenance and inspection, are located in the wet well, then it shall be mechanically ventilated at the time of access by maintenance personnel.

2. There shall be no interconnection between the wet well exhaust flow and the dry well ventilation systems. In pits over 15 feet deep, multiple inlets and outlets are desirable. Dampers shall not be used on exhaust or fresh air ducts, and fine screens or other obstructions in air ducts shall be avoided to prevent clogging. In climates where excessive

moisture or low temperature are problems, consideration should be given to installation of automatic heating and dehumidification equipment.

3. Switches for operation of ventilation equipment shall be marked and conveniently located above grade and near the pump station entrance. Consideration should be given also to automatic controls where intermittent operation is used. The fan drive shall be fabricated from nonsparking material in accordance with applicable codes and standards.

4. Where heat buildup from pump motors may be a problem, consideration should be given to automatic cooling and ventilation to dissipate motor heat.

5. Ventilation of wet wells in accordance with VOSH requirements may be either continuous or intermittent. Ventilation, if continuous, shall provide at least 12 complete air changes per hour; if intermittent, at least 30 complete air changes per hour. Such ventilation shall be accomplished by mechanical means.

C. Water supply. There shall be no cross connection between any potable water supply and a sewage pump station which under any conditions might cause contamination of the potable water supply. Any potable water supply brought to the station shall comply with conditions stipulated in the Virginia Waterworks Regulations (12 VAC 5-590). Where conditions do not warrant the installation of an approved reduced pressure zone backflow prevention device on the water supply line to the pump stations, other approved devices may be considered on a case-by-case basis.

D. Service. Provisions shall be made to facilitate removing pumps, motors, and other equipment without interruption of system service while providing all necessary worker safety features.

1. In accordance with VOSH requirements, suitable and safe means of access shall be provided to dry wells and wet wells containing equipment requiring inspection or maintenance. Compliance with all applicable VOSH and Uniform Statewide Building Code requirements is recommended. All ladders shall have slip-resistant rungs.

2. If the dry well or wet well floor is more than 10 feet below the entrance, special consideration shall be given to safety features such as harness lifts, ladder cages, spiral stairways, or intermediate landings. Intermediate landings should not exceed 10 foot vertical intervals.

E. Wet wells. Proper design of wet wells is essential to effective pump station operation.

1. The wet wells at major pumping stations and in those located in critical areas should be divided into two sections properly interconnected to facilitate repairs and cleaning.

2. The wet well size and control settings shall be designed and operated so as to avoid heat buildup in the pump motor due to frequent starting and to avoid septic conditions due to excessive detention time.

3. Provisions shall be made to prevent solids deposition. Where used, wet well fillets shall have a minimum slope of one-to-one to the hopper bottom. The horizontal area of the hopper bottom shall be no greater than necessary for proper installation and function of the inlet.

9 VAC 25-790-390. Reliability.

A. Purpose. Reliability provisions are based on a measurement of the ability of a component or system to perform its designated function without failure or interruption of service. Overflow criteria, such as a period of discharge, are utilized solely for the establishment of reliability classification for design purposes and are not to be construed as authorization for, or defense of, an unpermitted discharge to state waters.

1. The objective of achieving reliability protection is to prevent the discharge of raw or partially treated sewage to any waters and to protect public health and welfare by preventing backup of sewage and subsequent discharge to basements, streets and other public and private property. Provisions for continuous operability of pumping stations shall be evaluated in accordance with the appropriate reliability classification.

2. For Class I Reliability, alternate motive force sufficient to operate the station at peak flow rates being received shall be operating the station prior to the expiration of an allowable time period. The maximum allowable period will be the time transpiring between the high liquid level alarm and the occurrence of an overflow, or backup and subsequent discharge, at flow rates being received (except when an emergency holding basin is provided to satisfy the requirement for continuous operability). The transpired time to be considered allowable may be the critical (shortest) transpired time (peak flow rates) or a spectrum of transpired times keyed to the 24 individual hours of the day. Certain Reliability Class I pump stations, for which it is feasible to shut down or discontinue operation during periods of power failure without bypassing or overflowing, may be exempted from the continuous operability requirement. Pump stations which may qualify for the exemption can be broadly categorized as those which serve facilities or institutions which would be closed during periods of power failure, such as certain industrial plants, schools and recreational and park areas.

3. For Class II Reliability, alternate motive force sufficient to operate the station at peak flow rates being received shall be operating the station prior to the expiration of a 24-hour period commencing at the time an overflow or discharge subsequent to a backup begins.

4. Reliability Class III pump stations are not limited to a specific period of overflow or discharge, and will be considered on a case-by-case basis.

B. Continuous operability. The owner shall demonstrate, to the satisfaction of the department, that the time allowances for continuous operability will be met on a 24-hour basis. This information shall accompany the plans and specifications when submitted and shall be subsequently modified and resubmitted at any time in the future that the actual allowable time (transpiring between the high liquid level alarm and the time that an overflow or backup and subsequent discharge will occur at flow rates being received) becomes less than the allowable time claimed in the original submission. The demonstration shall include provision of instructions indicating the essentiality of routinely maintaining, and regularly starting and running, auxiliary and reserve units under field conditions. The following means for provision of continuous operability shall be acceptable:

1. Alternate power sources or auxiliary stand-by generator that can operate sufficient pumps to deliver the design peak flow.

2. Alternate drive arrangements whereby all pumps are backed by internal combustion motors with "Y" mechanical couplings to the pump drive shafts or to permanently mounted reserve pumps capable of delivering total peak flows.

3. Portable pump resources in accordance with this chapter.

4. An emergency overflow holding basin with capacity to retain a minimum of one day of station design flow and having provisions for recycling flow to the pump station.

C. Electrical power. The sources of electrical power required to operate pump stations shall be evaluated in accordance with the reliability classification of the pump station.

1. For Class I Reliability, electric power shall be provided by alternate feed from distribution lines which are serviced by alternate feed from transmission lines (e.g., 115 KV) where possible. The transmission lines shall have alternate feed from the generating source or sources. The capacity of each power source shall be sufficient to operate the pumps during peak wastewater flow conditions, together with critical lighting and ventilation. The requirement for alternate feed can be satisfied by either a loop circuit, a "tie" circuit, or two radial lines. Where alternate feed lines terminate in the same substation, the circuit feeding the pumping station shall be equipped with two or more in-place transformers. Where alternate feed is not possible, provision of auxiliary power sources will be considered.

2. External alternate distribution lines shall be completely independent. The two sets of alternate feed distribution lines should not be supported from the same utility pole and, if used, should neither cross over, nor be located in an area where a single plausible occurrence (e.g., fallen tree) could disrupt both lines. A minimum separation of 25 feet for underground routes shall be maintained unless a properly designed and protected conduit bank is utilized. This shall apply to service connections into the pump station. Devices should be used to protect the system from lightning.

3. For Class II Reliability, a single source feed is acceptable. If alternate power sources are provided for a Class II or III station, one in-place transformer and capability for connection of a mobile transformer may be provided where the alternate feed lines terminate in the same substation.

D. Power distribution. The design of power distribution circuitry and equipment provided within pump stations shall be in accordance with the reliability classification of the pump station.

1. Reliability Class I pump stations shall have the following features:

a. Final stepdown transformer on each electric feed line with adequate physical separation to prevent a common mode failure.

b. In addition, Reliability Class I pump stations shall be provided with separate buses for each power source.

c. Each power source shall remain separate and from separate distribution substations up to the transfer switch to preclude a common mode failure of both sources.

2. Reliability Class II and Class III pump stations may be equipped with a single final stepdown transformer, a single bus, a single motor control center, and a single power distribution system.

3. Breaker settings or fuse ratings shall be coordinated to effect sequential tripping such that the breaker or fuse nearest the fault will clear the fault prior to activation of other breakers or fuses, to the degree practicable.

9 VAC 25-790-400. Pumping equipment.

A. Proper location. Where practicable, the electric switchgear and motor control centers should be housed above grade and in a separate area from the dry well. All motors and control enclosures shall be adequately protected from moisture from the weather and water under pressure. In cases where equipment may be damaged by flooding from natural events, in such a manner as to cause excessive delays in restoring the pump station to design operating levels, the means of protecting or removing such equipment prior to flooding should be described in the Operation and Maintenance Manual. Motors located indoors and near liquid handling piping or equipment shall be, at least, of-splash-resistant design. Means for heating motors located outdoors or in areas where condensation may occur should be provided. On-site emergency power generation equipment shall be located above grade and be adequately ventilated. Fuel shall be stored in safe locations and in containers specifically designed for fuel storage.

B. Electrical protection. All electrical equipment design (motors, controls, switches, conduit systems, etc.) located in raw sewage wet wells or in totally or partially enclosed spaces where hazardous concentrations of flammable liquids, gases, vapors, or dusts may be present will be evaluated in accordance with the appropriate requirements of the National Electrical Code (e.g., Class I, Group D, Division I for ignitable gases or vapors, etc.) and VOSH requirements.

1. Three-phase motors and their starters shall be protected from electric overload and short circuits on all three phases.

2. All motors shall have a low voltage protection device which, on the reduction or failure of voltage, will cause and maintain the interruption of power to that motor. The low voltage protection device should protect each phase of 3-phase motors.

3. Consideration should be given to the installation of temperature detectors in the stator and bearings of larger motors in order to give an indication of overheating problems.

4. Wires in underground conduits or in conduits that may be flooded shall have moisture resistant insulation as identified in the National Electrical Code.

5. Concrete, metals, control and operating equipment, and safety devices shall, insofar as practical, be designed to protect against corrosion.

6. Electrical power devices or equipment used to convert single phase power to three phase power shall be dedicated to a single specific motor.

C. Testing. Provisions shall be included in the design of equipment requiring periodic testing, to enable the tests to be accomplished while maintaining electric power to all vital components. This requires being able to conduct tests such as actuating and resetting automatic transfer switches and starting and loading emergency generating equipment. The electric distribution system and equipment shall be designed to facilitate inspection and maintenance of individual items without interruption of operations.

D. Generator. The power capacity provided by the on-site emergency generator shall be in accordance with the reliability classification of the pump station. The automatic start system shall be completely independent of the normal electric power source. Air-starting systems shall have an accumulator tank or tanks with a volume sufficient to furnish air for starting the generator engine a minimum of three times without recharging. Batteries used for starting shall have a sufficient charge to permit starting the generator engine a minimum of three times without recharging. The starting system shall be appropriately alarmed and instrumented to indicate loss of readiness (e.g., loss of charge on batteries, loss of pressure in air accumulators, etc.)

E. The specifications shall require that the equipment manufacturers provide to the owner one complete set of operational instructions, equipment and maintenance manuals, with troubleshooting and emergency procedures for each major mechanical and electrical equipment item. The manuals shall contain drawings of equipment and a numbered parts list keyed to a list of components. Tools and such spare parts as may be needed shall also be specified.

9 VAC 25-790-410. Portable equipment and diversions.

A. Needs. Portable equipment (pumps or generator sets) shall be acceptable to satisfy the continuous operability requirements where, under critical conditions imposed by rush hour traffic, multiple pumping station failures, etc., the portable equipment transportation, connection and starting can be accomplished within allowable time periods.

1. Portable pumping equipment shall have the following provisions:

a. Pumping units shall have capability to operate between the wet well and the discharge side of the station.

b. Each station served by portable pumping equipment shall facilitate rapid and easy connection of lines.

2. Numbers of portable units and their pumping implementation capabilities that are simultaneously available to service pumping stations, which are provided continuous operability through the use of portable equipment, shall conform to the following, whichever shall yield the greater number:

a. The number shall be the maximum number of pumping stations (dependent on portable equipment for continuous reliability) that are on the same radial extremity (single source feed) of any electrical distribution circuit from the point of the radial extremity's intersection with circuitry that has alternate feed.

b. The number shall be equal to 5.0% of the number of pumping stations (dependent on portable equipment for continuous reliability).

3. Volume and head capabilities (pumps) or power watts (generators) of portable equipment shall be capable, singly or in combination, of operating the largest pump station dependent on portable equipment for continuous reliability.

B. Submittals. Plans and specifications for a pump station submitted to the area engineer proposing to use portable equipment to meet continuous operability requirements shall be accompanied by a completed "Portable Equipment for Sewage Pump Stations" form. A list of this information is included in 9 VAC 25-790-990.

1. The design submitted for sewerage systems that utilize portable equipment to meet the continuous operability requirements for sewage pump stations shall include the following information: (i) an inventory of the owner's portable equipment (pumps or generators) which lists numbers of units, capacities, storage locations, and assignment of this equipment by the owner; and (ii) an analysis of response times based on geographical locations within the owner's sewerage system service area.

2. The response time analysis should be based upon a work crew responding to an alarm from the pump station during the hour of the day that the peak flow to that station is expected to be received.

C. Controlled diversion. The provision of a high-level wet well-controlled diversion may be considered for pump stations of all reliability classes.

1. If a high-level wet well-controlled diversion is utilized, the overflow elevation shall be such that the maximum feasible storage capacity of the wastewater collection system shall be used before the controlled diversion is used. When a controlled diversion is utilized at a Reliability Class I pumping station, it shall be to a storage detention basin or tank. The storage volume shall be sized in accordance with the pump station's operating conditions and the constraints and conditions applicable to the owner's repair and maintenance capabilities. The storage volume shall provide, without overflow, not less than six hours detention capacity at the anticipated flow diversion rate.

2. Additional storage volume, or provisions for protection against overflows in critical areas, may be required.

9 VAC 25-790-420. Alarm systems.

A. The alarm system provided to monitor pump station operation shall meet the appropriate reliability requirements.

B. Class I. For Class I reliability, the alarm system shall monitor the power supplies to the station, auxiliary power source, failure of pumps to discharge liquid, and high liquid levels in the wet well and in the dry well, and shall include a test function. An on-site audio-visual alarm system shall be provided such that each announced alarm condition is uniquely identified. In addition, provisions shall be made for transmitting a single audible alarm signal to a central location where personnel competent to receive the alarm and initiate corrective action are either: (i) available 24 hours per day, or (ii) available during the periods that flow is received at the pump station. A sign indicating notification procedures (responsible persons, telephone numbers, etc.) to be followed in case of alarm actuation shall be displayed conspicuously.

C. Classes II and III. For Class II or III reliability, the alarm system shall monitor high liquid levels in the wet well. An on-site audio-visual alarm signal shall be provided. A sign indicating notification procedures (responsible persons, telephone numbers, etc.) to be followed in case of alarm actuation shall be displayed conspicuously.

D. Backup. A backup power supply, such as a battery pack with an automatic switchover feature, shall be provided for the alarm system, such that a failure of the primary power source would not disable the alarm system. A backup power supply for the alarm system should be provided for a Reliability Class I facility with dual electrical feed sources. Test circuits shall be provided to enable the alarm system to be tested and verified to be working properly.

9 VAC 25-790-430. Alternatives.

A. General. Wet well-dry well pump stations shall meet the applicable requirements for both types of systems. Both wet and dry wells shall be separated to prevent leakage of gas into the dry well. A separate sump pump or suitable means shall be provided in the dry well to remove leakage or drainage, with the discharge above the high water level of the wet well. Vacuum ejectors connected to a potable water supply will not be approved. All floor and walkway surfaces shall have an adequate slope to a point of drainage. Drainage shall be unobstructed by conduit, piping, etc., installed on the dry well floor.

B. Suction lift. Suction lift pump installations shall be designed to meet the applicable requirements of this chapter.

1. The capacity of suction lift pump stations shall be limited by the net positive suction head and specific speed requirements as stated on the manufacturer's pump curve under the most severe operating conditions.

2. All suction lift pumps shall be provided with an air relief line on the pump discharge piping. This line shall be located at the maximum elevation between the pump discharge flange and the discharge check valve to ensure the maximum bleed-off of entrapped air. Air relief piping shall have a minimum diameter adequate to purge air during priming. The use of 90° elbows in air relief piping should be avoided. A separate air relief line shall be provided for each pump discharge. The air relief line shall terminate in the wet well or suitable sump and open to the atmosphere.

3. Valving to prevent recycle of flow to the wet well should be provided on all relief lines. The air relief valves shall be located as close as practical to the discharge side of the pump. Automatic operating air relief valves may be used if the design of the particular valve is such that the valve will fail in the open position under varying head conditions. Unvalved air relief piping may lead to air entrainment in the sewage and will materially affect pump efficiency and capacity. Air entrainment shall be considered accordingly by the design consultant.

4. All pumps, connections, shut-off valves, and check valves shall be located in a separate vault either above or outside of the wet well, allowing accessibility to both the wet well and pump/valve vault for inspection, maintenance, etc.

5. Access to the wet well shall not be through a sealed vault. The dry well shall have a gas-tight seal when mounted directly above the wet well.

C. Submersible. Submersible pump station installations shall be designed to meet the applicable requirements of this chapter.

1. Submersible pumps shall be provided with equipment for disconnecting, removal, and reconnection of the pump without requiring personnel to enter the wet well.

2. Owners of submersible pumping facilities shall provide a hoist and accessories for removing the pumps from the wet well.

3. Electrical controls shall be located in a suitable housing for protection against weather and vandalism.

4. The shut-off valve and check valve on the discharge lines of pumps operating at flows greater than 25 gpm shall be located in a separate vault outside of the wet well allowing accessibility for inspection and maintenance.

D. Pneumatic ejectors. Pneumatic ejector stations shall be designed to meet the applicable requirements of this chapter. Pneumatic ejectors should not be directly connected to force mains. The ejector design features should include:

1. Ejector pots shall be vented to the atmosphere in such a manner as to prevent nuisance conditions.

2. Duplicate compressors shall be provided.

3. Pneumatic ejectors may utilize either stored or direct air systems. If a stored air system is utilized, the air storage chamber shall not enclose any piping, valves, or working parts.

4. Duplicate receiver pots shall be provided. The units shall be alternated in operation.

E. Grinder. Grinder pump installations shall be designed to meet the applicable requirements of this chapter.

1. Maintenance and operation service arrangements shall be identified to the division. Acceptable service arrangements shall include:

a. Right of access.

b. Adequate spare parts, spare units and service tools.

2. A single pumping unit for a single home or equivalent flow is acceptable, but the wet well capacity for a single family residence should be a minimum of 60 gallons.

3. Duplex pumping units shall be provided where two houses or equivalent flow are served by a single installation. The wet well or holding tank capacity shall be twice the requirements for a single house.

4. The alarm system should provide notice to residents of pump failure, including excessive high liquid levels. The alarm system should alert the operating staff of the location of pump failure.

5. Pumping equipment shall be capable of delivering flows at the design pressure of the sewer system. Cutter blades shall be driven with a minimum motor size of two horsepower, unless performance data, evaluated by the department, verifies that a smaller motor is suitable.

F. Septic tank effluent pump. Septic Tank Effluent Pumps (STEP) may be located within the effluent end of a single tank or within a separate vault external from the septic tank. The design for STEP facilities is described in published literature, such as the USEPA Technology Transfer Manual "Alternative Wastewater Collection Systems" (EPA/625/1-91/024), which may be used as a reference.

9 VAC 25-790-440. Force mains.

A. Capacity. The minimum size of force mains shall be four inches in diameter, except for grinder pumps and septic tank effluent (settled sewage) pumping systems, which shall be provided with a minimum diameter of one inch.

1. At pumping capacity, a minimum self-scouring velocity of two feet per second shall be maintained unless provisions for flushing are made. A velocity of eight feet per second should not be exceeded unless suitable construction methods are specified.

2. Air relief valves shall be placed at the high points in the force main to relieve air locking and shall be periodically exercised and maintained.

B. Connections. Force mains shall normally enter a gravity sewer system at a point no more than one foot above the flow line of the receiving manhole with a curved section to prevent air from traveling up into the force main. The force main should enter the receiving manhole with its center-line horizontal, and shall have an invert elevation which ensures a smooth flow transition to the gravity flow section. Special attention shall be paid to the design of the termination in order to prevent turbulence at this point. Whenever existing force mains are connected within a sewerage system in a manner that results in increased flow rates or pressure increase to the existing force mains, those existing force mains shall be examined by the owner. Existing force mains may be examined by internal visual inspections, flow or pressure testing, or other suitable means to verify hydraulic and structural adequacy to convey the actual or projected flow. The results of such inspections and tests shall be submitted with the design documents.

C. Materials. All pipe used for force mains shall be of the pressure type with pressure type joints. The force main shall be constructed of materials with a demonstrated resistance to deterioration from corrosion, acidity, and other chemical action.

1. Consideration should be given to the use of inert materials or protective coatings for either the receiving manhole or gravity sewer to prevent deterioration as a result of hydrogen sulfide or other chemical attack. These requirements should be provided for all force mains.

2. All force mains shall be tested at a minimum pressure of at least 50% above the design operating pressure for at least 30 minutes. Leakage shall not exceed the amount given by the formula contained in the most current AWWA Standard C-600.

D. Installation. Class A, B or C bedding (ASCE Manuals and Reports on Engineering Practice--No. 36, 1974 and the WPCF Manual of Practice--No. 9, 1970) or AWWA pipe installation conditions 3, 4 or 5 (ANSI/AWWA C600-82) shall be provided for installation of pipelines in excavated trenches. Installation of pipelines of flexible materials shall be in accordance with recognized standards.

Force mains shall be sufficiently anchored within the pump station and throughout the line length. The number of bends shall be as few as possible. Thrust blocks, restrained joints, or tie rods shall be provided where restraint is needed.

Article 3.
Sewage Treatment Works.

9 VAC 25-790-450. Treatment works design.

A. The sewage treatment process consists of a sequential, upstream to downstream, arrangement of unit operations that remove or modify contaminants through several treatment phases, including (i) primary, (ii) secondary, and (iii) tertiary. A conventional or established secondary treatment process will include primary treatment. Advanced wastewater treatment works include all three phases of treatment. Sewage treatment works should be designed to provide waste water treatment for the tributary sewage flows from either the estimated population 10 years hence or a capacity required by applicable state or federal requirements.

B. Location. A sewage treatment works site shall be located as far as practicable from any existing built-up commercial or residential area, which will probably develop within the design life of the treatment works. The treatment works site shall be (i) protected by a buffer zone, (ii) located to avoid flooding, (iii) provided with year-round access, and (iv) provided with ample area for any future expansion. The minimum distance between the locations of effluent discharges from separate treatment works on the same watershed shall be 500 feet.

C. Restrictions. All new primary and secondary sewage treatment unit operations shall provide the minimum buffer zones as shown in Table 2 (found in 9 VAC 25-790-460) unless they qualify for reduced requirements as provided in this chapter. Buffer zones for advanced treatment (AWT) and natural treatment operations will be established on a case-by-case basis considering the reliability requirements and process design. Buffer zones are areas of controlled or limited use.

1. Within buffer zones, neither residential uses, high density human activities, nor activities involving food preparation are to be established within the extent of the buffer zone. The extent of the buffer zone perimeter is measured from the treatment units. Buffer zone requirements for sewage sludge incinerator restrictions shall be established in accordance with applicable state and federal regulations.

2. The department may approve a reduction of up to one half of the listed buffer zone requirements based on one or more of the following factors: (i) site topography, (ii) prevailing wind directions, (iii) existence of natural barriers, (iv) establishment of an effective windbreak, (v) type of adjacent development, and (vi) provision of enclosed units, as described in this chapter.

3. The prevailing wind direction should be determined by on-site data. Local weather station records may be utilized if they are demonstrated to be applicable. Attention should be paid to both moderate and high speed winds since the high velocity winds often have a prevailing direction different from the prevailing direction of moderate winds.

4. A windbreak should be located on both sides of the treatment works normal to a line projected through the treatment works and the area that is to be protected, as close to the treatment works as practicable. An effective windbreak may be comprised of man-made or natural barriers that extend from the ground surface to a height of 16 feet. Alternatively, a cultivated tree windbreak may be developed by planting at least four rows of fast-growing evergreen trees (pine family preferred), planted on staggered 10-feet centers. Rows should be spaced no greater than 16 feet apart. The minimum tree height at planting shall be six feet, unless taller trees are required in order to provide a windbreak which will be immediately effective. The variety of tree used should be readily adaptable to the soil and climate at the treatment works site.

5. Reduced buffer distances will be established for enclosed treatment unit operations or processes. Covered units shall be provided with screened intake openings and positive forced draft ventilation and shall have provisions for removal of aerosols and odors from the exhaust.

6. Owners of existing sewage treatment works or those treatment works proposed for upgrading shall take whatever steps possible to provide as much of the required buffer as is reasonably possible under the specific existing conditions at each treatment works site. Wherever a demonstrated nuisance problem does exist, corrective action (wind breaks or odor control measures, for example) shall be undertaken.

7. The required buffer zone shall be maintained by adequate legal instruments such as either ownership, recorded easements, or restrictive zoning throughout the life of the treatment works.

8. The director may consider exceptions to the listed buffer zone requirements in accordance with this chapter.

D. Flooding. All mechanical and electrical equipment that could be damaged or inactivated by contact with or submergence in water (motors, control equipment, blowers, switch-gear, bearings, etc.) shall be physically located above the 100-year level or otherwise protected against the 100-year flood/wave action damage. All components of the treatment works shall be located above or protected against the 25-year flood/wave action level and remain fully operational. Consideration should be given to designing the treatment works in such a way as to facilitate the removal of vital components during more extreme flood events.

E. Closure. A closure plan shall be submitted to the department in accordance with this chapter.

9 VAC 25-790-460. Standards.

A. The minimum degree of treatment to be provided shall be adequate in design to produce an effluent in accordance with this chapter, that will comply with the provisions of the State Water Control Law and federal law, and any water quality standards or effluent limitations adopted or orders issued by the State Water Control Board or Department of Environmental Quality. The expected performance levels of conventional treatment processes are described in subsection F of this section.

B. Industrial flows. Treatment works receiving industrial wastewater flows at a rate or volume exceeding 90% of the combined average daily influent flow can be designed and operated through the applicable requirements imposed by the State Water Control Board/Department of Environmental Quality, provided that public health and welfare protection issues are resolved. Otherwise, consideration shall be given to the character of industrial wastes in the design of the treatment works. In such cases, the treatability characteristics of the combined (sewage and industrial) wastewater shall be provided and addressed in the treatment process design. Pilot-scale testing as described in this chapter may be required to predict the full-scale treatment works operations.

C. Design loadings. Design loading refers to the established capacity of a unit operation or treatment process to reliably achieve a target performance level under projected operating conditions. Component parts and unit operations of the treatment works shall be arranged for greatest operating convenience, flexibility, economy, and to facilitate installation of future units.

1. Treatment works to serve existing sewerage systems shall be designed on the basis of established average sewage characteristics with sufficient capacity to process peak loadings. Excessive inflow/infiltration is an indication of deficiencies in the sewerage system and the design engineer shall provide an acceptable plan for eliminating or handling these excessive flows so that there will be no discharge of inadequately treated wastewaters or impairment of the treatment process.

2. A new treatment works must be designed in accordance with anticipated loadings. Table 3, found in this section, presents generally accepted minimum design flows and loadings. Deviations from Table 3 shall be based on sound engineering knowledge, experience and acceptable data substantiated in the design consultant's report. Numbers of persons per dwelling shall be based upon planning projections derived from an official source.

3. The design of treatment process unit operations or equipment shall be based on the average rate of sewage flow per 24 hours except where significant deviation from the normal daily or diurnal flow pattern is noted. The design flow for industrial wastewater flow contributions shall be determined from the observed rate of flow during periods of significant discharge or, in the case of proposed or new contributions, the industrial owner shall provide flow projections based on existing facilities of a similar nature. The following factors shall be included in determining design flows:

a. Peak rates of flow delivered through conduits as influent to the treatment process unit operations.

b. Data from similar municipalities, if applicable.

c. Wet weather flows.

4. The design organic loading should be based on the results of acceptable analytical testing of the wastewater or similar wastewater and shall be computed in the same manner used in determining design flow.

5. All piping and channels shall be designed to carry the maximum expected flow. If possible, the influent interceptor or sewer shall be designed for open channel flow at atmospheric pressure. If a force main is used to transmit the influent to the treatment works, a surge or equalization basin should be provided upstream of biological unit operations to provide a more uniform loading. Bottom corners of flow channels shall be filled and any recessed areas or corners where solids can accumulate shall be eliminated. Suitable gates and valves shall be placed in channels to seal off unused sections which might accumulate solids and to provide for maintenance.

D. Pilot plant studies. Pilot plants are defined as small scale performance models of full size equipment or unit operation design. The physical size of pilot plants varies from laboratory bench-scale reactors, with volumetric capacities of one or more liters up to several gallons, up to larger capacity arrangements of pumps, channels, pipes and tankage capable of processing thousands of gallons per day of wastewater.

Pilot scale studies are to include detailed monitoring of treatment performance under operating conditions similar to design sizes, including the proper loading factors. A sampling and analytical testing program is to be developed by the owner and evaluated by the department in order that the results of pilot plant studies can be utilized to verify full size designs.

E. Grease management. An interceptor basin or basins shall be provided to separate oil and grease from wastewater flows discharged to sewage collection systems whenever such contributions will detrimentally affect the capacity of the collection system or treatment works such that permit violations will actually or potentially occur, or such contributions will result in an actual or a potential threat to the safety of the operational staff. Interceptor basins shall be located in compliance with the Statewide Building Code as close to the source of oil and grease as practical. Interceptor basins shall be sized in accordance with the applicable building codes and local standards but shall be designed as a minimum to retain the volume of flow containing the oil or grease for each continuous discharge occurrence. But interceptor basins shall also provide a minimum volume in accordance with the following:

1. Provide two gallons of volume for each pound of grease received; or

2. Provide a minimum retention period of three hours for the average daily volume of flow received.

Interceptor basins shall be routinely maintained, including the periodic, scheduled removal of accumulations of oil and grease, within a portion of the basin volume as necessary, to prevent detrimental effects on system operation. The oil and grease shall be handled and managed in accordance with state and federal laws and regulations.

F. Expected performance. Conventionally designed sewage treatment unit operations and processes should result in an expected performance level when processing design loadings in accordance with this chapter (see Table 4 of this section). A conventional arrangement of unit operations would include primary and secondary phases. The primary phase involves the use of suspended solids setting basins called primary clarifiers. The secondary phase typically includes a biological reactor and secondary clarifier to maintain a population of microorganisms (biomass) capable of achieving a significant reduction of organic matter (Biochemical Oxygen Demand) contained in the sewage. Advanced treatment processes will include primary, secondary and tertiary phases, typically involving filtration unit operations. Conventional processes can be modified to provide for reduced levels of nutrients in the treated effluent as described in Article 9 (9 VAC 25-790-870 et seq.) of this part. The use of nonconventional processes to achieve required performance levels shall be considered in accordance with the provisions of Article 2 (9 VAC 25-790-380 et seq.) of this part.

TABLE 2.
BUFFER ZONE REQUIREMENTS FOR PRIMARY AND SECONDARY SEWAGE TREATMENT UNIT OPERATIONS*.

A. Unit Operations That Are Totally Enclosed [(1)]	
DESIGN FLOW, gpd	BUFFER ZONE [(4)]
1. <1,000 2. >1,000 to <500,000 3. Greater than 500,000	None 50 feet 100 feet
B. Unit Operations Using Low Intensity Mixing or Quiescent System [(2)]	
DESIGN FLOW, gpd	BUFFER ZONE [(4)]
1. <40,000 2. >40,000 to <500,000 3. Greater than 500,000	200 feet 300 feet 400 feet
C. Unit Operations Using Turbulent High Intensity Aeration or Mixing [(3)]	
DESIGN FLOW, gpd	BUFFER ZONE [(4)]
1. <40,000 2. >40,000 to <500,000 3. Greater than 500,000	300 feet 400 feet 600 feet

*Notes:

[(1)] For example, package plant with units totally enclosed as an integral part of its design and manufacture. A package plant treatment works is defined by these regulations as a preengineered and prefabricated structural arrangement of tankage and channels with all necessary components for onsite assembly and installation. The design flow of package plants should be less than 0.1 mgd. Also frequent agricultural use of Class I treated sludge.

[(2)] For example, covered basins, bottom tube aerated facultative lagoons or ponds, or surface flow application of treated effluent. Also, frequent agricultural use of Class II treated sludge.

[(3)] For example, uncovered surface mixed basins or trajectory spray irrigation for land application of treated effluent. Also frequent agricultural use of Class III treated sludge.

[(4)] Discharge locations shall be located no closer than 100 feet and up to 200 feet from any private or public water supply source.

TABLE 3.
CONTRIBUTING SEWAGE FLOW ESTIMATES TO BE USED AS A DESIGN BASIS FOR NEW SEWAGE WORKS.

Discharge facility [(1)]	Contributing Design Units	Flow gpd	BOD_5 #day[(3)]	S.S. #day	Flow duration, hours
Dwellings	Per person	100[(2)]	0.2	0.2	24
Schools w/showers and cafeteria	Per person	16	0.04	0.04	8
Schools w/o showers w/cafeteria	Per person	10	0.025	0.025	8
Boarding Schools	Per person	75	0.2	0.2	16
Motels @ 65 gal. per person (rooms only)	Per room	130	0.26	0.26	24
Trailer courts @ 3	Per trailer	300	0.6	0.6	24

persons/trailer					
Restaurants	Per seat	50	0.2	0.2	16
Interstate or through highway restaurants	Per seat	180	0.7	0.7	16
Interstate rest areas	Per person	5	0.01	0.01	24
Service Stations	Per vehicle serviced	10	0.01	0.01	16
Factories	Per person/per 8-hr. shift	15-35	0.03-0.07	0.03-0.07	Oper. Per.
Shopping centers	Per 1,000 square foot of ultimate floor space	200-300	0.1	0.1	12
Hospitals	Per bed	300	0.6	0.6	24
Nursing Homes	Per bed	200	0.3	0.3	24
Doctor's offices in medical centers	Per 1000 square foot	500	0.1	0.1	12
Laundromats, 9-12 machines	Per machine	500	0.3	0.3	16
Community colleges	Per student & faculty	15	0.03	0.03	12
Swimming pools	Per swimmer	10	0.001	0.001	12
Theaters (drive-in type)	Per car	5	0.01	0.01	4
Theaters (auditorium type)	Per seat	5	0.01	0.01	12
Picnic areas	Per person	5	0.01	0.01	12
Camps, resort day & night w/limited plumbing	Per camp site	50	0.05	0.05	24
Luxury camps w/flush toilets	Per camp site	100	0.1	0.1	24

Notes:

(1) Colleges, universities and boarding institutions of special nature to be determined in accordance with subdivision B 2 of this section.

(2) Includes minimal infiltrations/inflow (I/I) allowance and minor contributions from small commercial/industrial establishments.

(3) #/Day - Denotes pounds per day.

TABLE 4.
EXPECTED PERFORMANCE FOR VARIOUS CONVENTIONAL TREATMENT PROCESSES.

Effluent Value Range (1) (mg/l)

A. Primary/secondary treatment process.

	BOD_5 (2)	TSS (2)
1. Primary	100-180	100-150
2. Facultative Aerated Lagoon a. With Clarification b. Without Clarification	24-45	24-30
3. Biological contactors	24-50	24-50
4. Activated Sludge	24-30	24-30
5. Biological Plus Filtration (3)	10-20	5-15
6. Primary plus constructed wetlands (4)	24-40	24-40
7. Primary plus Aquatic Ponds (5)	20-30	20-30

B. Advanced treatment process.

	BOD_5	TSS	PO_4-P	NH_3-N
1. Physical chemical [6] and	45-95	20-70	1-10	20-30
a. F	20-70	1-20	1-10	20-30
b. F & AC	5-10	0.1-10	1-10	20-30
2. Biological [7] and				
a. C & S	12-20	12-24	0.5-10	5-30
b. C, S, & F	6-11	0.5-15	0.5-10	5-30
c. C, S, F & AC	1-5	0.1-5	0.1-10	5-30
d. Microscreening				
(1) 21 microns @ 5 GPM/sq. ft.	2-14	1-14	20-30	5-30
(2) 35 microns @ 8 GPM/sq. ft.	5-20	3-17	20-30	5-30
3. BNR [8]	20-30	20-30	2-4	1-3

4. Other biological and natural treatment processes evaluated on a case-by-case basis.

NOTES:

(1) Ranges reflect normal expected upper and lower values for process, performance, considering design and operations variability. Upper range value reflects performance expected for conventional loadings.

(2) Effluent values for soluble phosphorus and ammonia nitrogen are not given for conventional primary and biological processes since these are not designed as nutrient removal processes. However, phosphorus is removed in biological sludge and ammonia is oxidized to nitrate in biological effluents. Typical effluent values range from 4 to 5 mg/l of total phosphorus and from nearly 0 to more than 30 mg/l ammonia, for fully nitrified to unnitrified effluent.

(3) Coagulant and polymer addition prior to filter to be provided.

(4) Subsurface flow microbial-plant filter system with a minimum detention of three days, or surface flow system with a minimum retention of six days.

(5) Aquatic pond providing one acre of surface area (5-foot depth) per 200 population equivalent or less.

(6) Physical - Chemical: means coagulation by aluminum, iron or other metal salts or, precipitation by lime, followed by clarification and may include filtration. Unit processes include, as a minimum, flash mix, flocculation, and sedimentation. Filtration operations will be necessary to achieve effluent TSS levels of 15 mg/l or less.

(7) Biological: means any of the biological treatment processes including activated sludge and its process variations, attached growth systems including various filters, and facultative and fully aerated lagoons which are capable of producing a secondary effluent containing 30 mg/l BOD_5 and TSS or less.

(8) Biological Nutrient Removal performance will be a function of influent levels of nutrients with typical influent values of 4 to 6 mg/l of PO_4-P and 20 to 40 mg/l of NH_3-N. Additional nitrification operations would be necessary to achieve TKN levels of less than 10 mg/l. Denitrification may produce effluent total nitrogen levels of 5 to 10 mg/l.

LEGEND:
C = Coagulation S = Sedimentation F = Filtration and AC = Activated Carbon

BNR = Biological Nutrient Removal

9 VAC 25-790-470. Treatment works details.

A. Equipment. The specifications should be so written that the installation and essential items of mechanical equipment will be certified by a representative of the manufacturer. The specifications shall require that the equipment manufacturers provide to the owner one complete set of operational instructions, equipment and maintenance manuals, and emergency procedures for each essential mechanical and electrical equipment item. The manuals shall contain drawings of equipment and a numbered parts list keyed to a list of components.

B. Instrumentation. Insofar as possible, all indicating, recording, and totalizing flow meters shall be identical so that repair components and charts are interchangeable. Recording equipment for dissolved oxygen, temperature, pH, and other operating data, along with flow metering equipment, shall be located in areas free from high humidity, extreme temperatures, and corrosive gases. Instrumentation requirements for each treatment works shall be decided on a case-by-case basis.

Facilities for measuring the volume of sewage flows shall be provided at all treatment works. Treatment works having a capacity of equal to or less than 40,000 gallons per day shall be equipped with a primary metering device such as a

Parshall flume with separate float well and staff gauge, weir box with plate and staff gauge, or other approved devices, as a minimum unless nonfluid contact measuring devices are provided. All treatment works having a capacity of greater than 40,000 gallons per day shall be equipped with indication, recording, and totalizing equipment. The recording scale shall be sufficient to accurately record and depict the flow measured. Flows passed through the treatment works and flows passed through controlled diversions shall be measured in a manner that will allow them to be distinguished and separately reported.

C. Component isolation. Properly located and arranged diversion piping or structures shall be provided so that any component of the treatment works process can be independently operated in accordance with the reliability classification, or removed from service independently for inspection, maintenance, and repairs. Adequate access and removal space shall be provided around all components to provide for proper maintenance or removal and replacement without interfering with the operation of other equipment. Due consideration shall be given to the need for lifting and handling equipment available to aid in the maintenance and replacement of all components. In addition, the placement of structures and other devices, such as pad-eyes and hooks to aid handling of heavy or large components, should be considered in the preliminary design. These criteria for adequate access and handling equipment do not apply to the removal or replacement of large tanks, basins, channels, or wells. Lines feeding chemicals or process air to basins, wet wells, and tanks shall be designed to enable repair or replacement without drainage of the basins, wet wells, or tanks.

D. Maintenance provisions. The design of a treatment works should facilitate access for both routine maintenance and equipment failure response.

1. Provisions should be made for flushing, with water or air, all scum lines, sludge lines, lime feed and lime sludge lines, and all other lines that are subject to clogging. All piping subject to accumulation of solids over a long period of time should be arranged in a manner to facilitate mechanical cleaning if possible. The design shall be such that flushing and mechanical cleaning can be accomplished without causing violation of effluent limitations or without cross-connections to the potable water system.

2. Provisions should be made for dewatering each unit. Drain lines should discharge to points within the system such that maximum treatment of the contents of the drained unit is provided. Due consideration shall be given to the possible need for hydrostatic pressure relief devices. Where practicable, all piping shall be sloped or have drains (drain plug or valve) at the low points to permit complete draining. Piping shall not be installed with isolated pockets that cannot be drained.

3. Concrete, metals, control and operating equipment, and safety devices shall, insofar as practical, be designed to protect against corrosion, moisture and heat induced damage.

4. Positive identification of the content of a piping system shall be by lettered legend giving the name of the contents. Arrows should be used to indicate direction of flow. Legends shall be applied close to valves and adjacent to changes in direction, branches and where pipes pass through walls or floors, and at frequent intervals on straight pipe runs. The lettering shall be of such color, size, and location to be clearly visible and readable.

5. A complete outfit of tools and accessories for the treatment works operator's use, such as wrenches, valve keys, rakes, shovels, etc., and such spare parts as may be needed, shall be specified as either contractor or owner furnished. A portable pump is desirable. Readily accessible storage space and work bench facilities shall be specified. Consideration shall be given to provision of a garage area that would also provide space for large equipment maintenance and repair.

6. Concrete, paved, or gravel walkways shall be provided for access to all units. Where possible, steep slopes and narrow stairways shall be avoided to increase access for maintenance. Surface water shall not be permitted to drain into any units. Provision should be made for erosion protection and landscaping, particularly when a treatment works must be located near residential areas.

E. Essential facilities. The design of treatment works shall include both proper physical support for operation personnel and specific safety features to protect operators and visitors from exposure to hazards.

1. A supply of potable water with adequate pressure shall be provided for use in the laboratory and bathroom facilities. All potable water supplies within the treatment works shall be protected with reduced pressure zone backflow prevention devices. To facilitate cleaning wet wells, tanks, basins, and beds, water supplied from a nonpotable water system or the treatment works effluent may be supplied at these points by means of an adequately pressurized water system with hydrants or hose bibs having minimum outlets of one inch in diameter.

The potable water supply line to each treatment works shall be equipped, as a minimum, with an approved reduced-pressure zone backflow preventer. These devices shall be installed in an above-ground location, no more than 36 inches above the ground floor elevation and with adequate clearance for access on all sides, to prevent corrosion and to allow for adequate, quick service and periodic inspections. Designers shall consult with the appropriate field office of the department for such requirements at individual treatment works in accordance with the Waterworks Regulations (12 VAC 5-590).

Where it is not possible to provide potable water from a public water supply, a separate well may be provided. Location and construction of the well shall comply with requirements of the department.

2. All sewage treatment works shall be provided with or have ready access to a toilet and lavatory. For a treatment works at which the operator is required to be on duty for eight or more hours per day, a shower shall also be provided.

3. Minimum laboratory space for treatment works not performing BOD and suspended solids testing on-site shall be 50 square feet of floor space with 20 square feet of bench area. Treatment works providing on-site BOD, suspended solids, or fecal coliform analysis shall provide a minimum of 400 square feet of floor space and 150 square feet of bench space. If more than two persons will be working in the laboratory at any given time, 100 square feet of additional space should be provided for each additional person. Advanced sewage treatment works shall provide a minimum of 100 additional square feet of floor space, with a proportionate increase in bench space. On-site laboratories shall be isolated from treatment works equipment, vehicular traffic, etc., so as to render the laboratory reasonably free from the adverse effects of noise, heat, vibration, and dust in accordance with VOSH requirements.

4. Safety provisions should protect operators and visitors at treatment works from exposure to hazards in accordance with VOSH requirements. The designer should refer to the applicable occupational safety and health standards of the Virginia Department of Labor and Industry for the appropriate requirements. The following shall be required as a minimum, as applicable:

a. Enclosing the treatment works site with a fence designed to discourage the entrance of unauthorized persons and animals.

b. Providing adequate lighting, installing handrails, and establishing access guards, where necessary, and posting "No Smoking" signs in hazardous locations.

c. Providing first aid supplies and safety equipment, including protective clothing and equipment such as gas masks, goggles and gloves.

d. Providing explosion-proof electrical equipment, nonsparking tools, etc. in work areas where hazardous conditions may exist, such as digester vaults and other locations where potentially explosive atmospheres of flammable gas or vapor with air may accumulate.

e. Providing properly grounded and insulated electrical wiring, with no part of the treatment works piping being used for grounding.

f. Providing railroad type manhole steps with slip-proof rungs, unless access is to be provided by lifting devices. The railroad type step is designed to help prevent foot slippage off the ends of the rungs. Also, providing intermediate landings or other suitable protection between height intervals of 10 feet or less, unless adequate lifting devices are to be provided.

g. Providing adequate protective storage for flammable and hazardous materials and safety devices for gas collection piping.

h. Providing adequate ventilation for all areas subject to accumulation of hazardous or toxic gases and providing equipment (accuracy of + or - 5%) for measuring the concentration of gases in the atmosphere of confined spaces, enclosed areas, underground areas, or other areas where hazardous gases may accumulate or oxygen deficiencies may occur. Providing a portable blower and hose sufficient to ventilate accessed confined spaces.

i. Locating heating devices with open flames in separate rooms with outside entrances located at grade level or above.

j. Locating laboratory and office space at sewage treatment works to minimize interference from motors, generators, compressors, etc. and providing adequate floor slope to a point of drainage.

k. Providing stairways with a slope of 30° to 50° from the horizontal, with risers all of equal height, and with handrails on the open sides of all exposed stairways and stair platforms.

F. Odor control. The potential for odor problems at new treatment works shall be evaluated. The evaluation shall include possible sources of odors, types of odors, and various methods (i.e., covered units, physical treatment, chemical treatment, or biological treatment) of controlling odors. Provisions for odor control shall be included in the design if the sewerage system is primarily composed of force mains or otherwise provides lengthy retention times (i.e., on the order of two or three days), or if the treatment works will provide raw sludge holding, raw sludge dewatering, or thermal treatment. Odor control provisions should be considered for sludge digestion processes, sludge dewatering processes, preliminary and primary sewage treatment processes, and other processes that provide the opportunity for gas transfer or gas stripping activities to occur.

9 VAC 25-790-480. Treatment works outfalls.

A. The effluent discharge line or outfall shall be designed with sufficient capacity to transmit the maximum expected flow in a manner so as to prevent flooding of the treatment process while providing optimum dispersion of the treated effluent into the receiving waters.

B. Velocity. The velocity in the outfall at design average flow shall be a minimum of 1-1/2 feet per second to avoid any settling of solids. Velocities should not exceed the recommendations of the pipe manufacturer with respect to maximum velocities to avoid pipe erosion or scour and should be less than eight feet per second to avoid excessive head loss or disruption of the receiving water channel.

C. Structures. The outlet structure should be submerged during design low flow conditions in the receiving water channel, unless adequate dispersion can be achieved without such submergence. The outlet structure should be designed to provide effective dispersion of effluent into the receiving body of water as established by the certificate or permit issued. Additional provisions for dispersion of effluent may be required, based on public health and welfare protection and water quality considerations in accordance with downstream uses.

1. The outfall, where practicable, shall be of gravity sewer design and extend beyond the design low water level of the receiving body of water and account for coastal erosion if necessary. The effluent discharge shall remain submerged if required to maintain water quality standards or protect public health and welfare.

2. Headwalls may be used where adequate dispersion will be obtained without requiring that the outfall be submerged. The design shall include measures to prevent erosion and foaming problems as a result of the discharge.

3. When a diffuser mechanism is provided, the design shall take into account the range of current velocities and directions in the vicinity of the diffuser.

Diffuser ports shall be spaced and located so as to avoid interference between adjacent jet plumes and sized so as to minimize head loss and maximize initial dispersion of the effluent into the receiving water.

D. Protection. The outfall shall be designed and constructed to protect against the effects of erosion, flood waters, tides, ice, boating and shipping, and other hazards, and to insure structural stability and freedom from stoppage.

9 VAC 25-790-490. Reliability protection.

A. Reliability is a measurement of the ability of a component or system to perform its designated function without failure or interruption of service. Overflow criteria, such as a period of discharge, are utilized solely for the establishment of reliability classification for design purposes and are not to be construed as authorization for or defense of an unpermitted discharge to state waters. The treatment works design shall provide for satisfactory operation during power failures, flooding, peak loads, equipment failure, and maintenance shut-down (in accordance with the requirements of the appropriate reliability class). Such design features include: (i) additional electrical power sources; (ii) additional flow storage capacity; and (iii) additional treatment unit operations, that provide for alternate operation in accordance with the issued certificate permit requirements.

B. Power feed. For Class I Reliability, two separate and independent sources of power feed shall be provided. Each source shall be capable of maintaining continuous treatment works operation at peak design flow during power failures, flooding, or equipment malfunction. Certain Reliability Class I treatment works for which it is feasible to shut down or discontinue treatment works operation during periods of power failure without bypassing or violating effluent limitations may be exempt from the alternate feed requirement.

1. Class I Reliability treatment works that may qualify for the alternate feed exemption can be broadly categorized as (i) those that serve facilities or institutions that could be closed during periods of power failure, such as certain industrial plants, schools, and recreational and park areas; (ii) those equipped with an emergency overflow holding basin with sufficient capacity to retain a minimum of one day of treatment works design flow and having provisions for recycle to the treatment works; and (iii) those with sufficient operational resources for which it can be demonstrated that projected power failures will not result in public health problems, water quality damage, or socio-economic resource losses.

2. Single source power feed is acceptable for Reliability Class II and III systems or works.

C. Power source. Electric power shall be provided by alternate feed from distribution lines that are serviced by alternate feed from transmission lines (e.g., 115KV) where possible. The transmission lines shall have alternate feed from the generating source or sources. The requirement for alternate feed can be satisfied by either a loop circuit, a "tie" circuit, or two radial lines. Where alternate feed lines terminate in the same substation, the substation shall be equipped as follows:

1. Reliability Class I: two or more in-place transformers.

2. Reliability Class II and Class III: one in-place transformer and capability for a connection of a mobile transformer.

On-site power generating equipment may be used as a substitute for alternate utility source feed. The capacity of the back-up power source shall be sufficient to operate all components vital to wastewater treatment operations during peak wastewater flow conditions, together with critical lighting and ventilation.

D. Power systems. External power distribution lines to a Class I Reliability Treatment Works shall be completely independent (i.e., both power lines cannot be carried on the same pole, cannot be placed in the same underground conduit, or cannot cross in their route to the treatment works) where possible. Minimum separation between alternate lines of 75 feet for above ground routes and 25 feet for underground routes shall be maintained. This shall also apply to service connections into the sewage treatment works. Devices should be used to protect the system from lightning.

1. Reliability Class I treatment works shall have a final step down transformer on each electrical feed line with adequate physical separation between them to prevent a common mode failure. In addition, Reliability Class I treatment works shall be provided with separate buses for each power source and separate independent internal power distribution systems up to the transfer switch for all critical components. The electrical power transfer to the alternate source should occur within 10 minutes of the time of failure of the primary power source.

2. Breaker settings or fuse ratings shall be coordinated to effect sequential tripping such that the breaker or fuse nearest the fault will clear the fault prior to activation of other breakers or fuses, to the degree practicable.

3. Where practicable, the electric switchgear and motor control centers shall be housed in a separate room from the liquid processing equipment. All outdoor motors shall be adequately protected from the weather. Motors located indoors and near liquid handling piping or equipment shall be, at least, of splash-proof design. Means for heating motors located outdoors or in areas where condensation may occur should be provided. On-site emergency power generating equipment shall be located above grade and be adequately ventilated. Fuel shall be stored in safe locations and in containers specifically designed for fuel storage.

a. All electrical equipment (motors, controls, switches, conduit systems, etc.) located in raw sewage wet wells or in totally or partially enclosed spaces where hazardous concentrations of flammable liquids, gases, vapors, or dusts may be present shall comply with the National Electrical Code, including the requirements for Class I, Group D, Division 1 locations.

b. Three-phase motors and their starters shall be protected from electric overload and short circuits on all three phases.

c. Large motors shall have a low voltage protection device that, on the reduction or failure of voltage, will cause and maintain the interruption of power to that motor.

d. Consideration should be given to the installation of temperature detectors in the stator and bearings of large motors in order to give an indication of overheating problems.

e. Wires in underground conduits or in conduits that can be flooded shall have moisture resistant insulation identified in the National Electrical Code.

4. The means for starting an on-site emergency power generator shall be completely independent of the normal electric power source. Air-starting systems shall have an accumulator tank or tanks with a volume sufficient to furnish air for starting the generator engine a minimum of three times without recharging. Batteries used for starting shall have a sufficient charge to start the generator engine a minimum of three times without recharging. The starting system shall be appropriately alarmed and instrumented to indicate loss of readiness (e.g., loss of charge on batteries, loss of pressure in air accumulators, etc.).

5. Testing provisions shall be included in the design of essential equipment requiring periodic testing to enable the tests to be accomplished while maintaining electric power to all vital components. Such provisions would involve an ability to conduct tests, such as actuating and resetting automatic transfer switches and starting and loading emergency generating equipment without taking essential equipment off-line. The electric power distribution system and equipment shall be designed to facilitate inspection and maintenance of individual items without interruption of operations.

E. Flow Storage. In combination with provisions for electrical power reliability, the use of flow storage and additional unit operations should be evaluated. Additional flow storage capacity should provide up to a 24-hour detention of the peak design flow. Additional unit operations could involve chemical clarification, filtration, additional disinfection capacity, or use of natural treatment technology for enhancing effluent quality.

F. Alarm systems. An audiovisual alarm system to monitor the condition of equipment whose failure could result in a bypass or a violation of effluent limitations shall be provided for all treatment works. Alarms shall also be provided to monitor conditions which could result in damage to vital components.

1. For continuously manned treatment works, the alarm system shall sound and be visible in areas normally manned and in areas near the equipment being monitored.

2. Treatment works not continuously manned shall have, in addition to a local audiovisual alarm, provisions for transmitting an audible alarm to a central location where personnel competent to receive the alarm and initiate corrective action are available 24 hours per day or during the period of time that the treatment works receives influent flow.

3. The following requirements apply to all treatment works:

a. The on-site alarm system should be designed in such a manner that each announced condition is uniquely identified.

b. A back up power supply, such as a battery pack with an automatic switchover feature, shall be provided for the alarm system (such that a failure of the primary power source would not disable the alarm system), unless an adequate alternate or backup power source is provided.

c. Test circuits shall be provided to enable the alarm system to be tested and verified to be working properly.

Article 4.
Preliminary Processes.

9 VAC 25-790-500. Screening.

A. Conventional preliminary treatment shall include adequate screening to remove solids and debris that could interfere with the performance of downstream unit operations. The process design shall address the means of proper waste management for screenings.

B. Requirements. Protection for pumps and other equipment shall be provided by installing large openings, one inch or more, coarse screens, or bar racks, and smaller openings screens. All screen equipment and facilities shall be readily accessible for maintenance. Small openings, fine screening, or comminution should follow grit removal, which should be preceded by coarse screening. Screen locations are to be provided as follows:

1. Manually cleaned screens shall be provided at all sewage treatment works unless adequate redundant mechanical screens are provided and manually cleaned screens shall be located in open areas with easy access. Mechanical screens that can be manually cleaned upon mechanical failure may be used to meet this requirement.

2. Manually cleaned screens located in deep pits shall be provided with stairway access, adequate lighting and ventilation, and convenient and adequate means for removing screenings.

3. Screening devices installed in a building where other equipment or offices are located shall be separated from the rest of the building, provided with separate outside entrances, and provided with adequate means of ventilation.

C. Design. Clear openings between the bars of coarse screens should be from one to 1-3/4 inches. Other size openings will be considered on a case-by-case basis. Coarse screen design shall provide for installation such that the screening equipment can be conveniently and safely accessed for maintenance and management of screenings.

1. Where a single mechanically cleaned screen that cannot be manually cleaned upon mechanical failure is used, an auxiliary manually cleaned screen shall be provided.

2. Where two or more mechanically cleaned screens are used, the design shall provide for taking any unit out of service without sacrificing the capability to handle the peak design flow.

3. Manually cleaned screens, except those for emergency use, shall be placed on a slope of 30 to 60 degrees with the horizontal.

4. All mechanical units that are operated by timing devices shall be provided with auxiliary controls which will set the cleaning mechanism in operation at predetermined high water levels.

5. The design or electrical fixtures and controls in enclosed places where gas may accumulate will be evaluated in accordance with the National Electrical Code specifications for hazardous conditions.

6. The use of fine mesh static or mechanical screens as an adjunct to or in lieu of sedimentation will be considered on a case-by-case basis.

D. Flow control. At the normal operating flow conditions, approach velocities should be no less than 1.25 feet per second, to prevent settling, and no greater than 3.0 feet per second, to prevent forcing materials through the openings.

1. The approach flow velocity shall be calculated from a vertical projection of the screen openings on the cross-sectional area between the invert of the channel and the flow line.

2. The screen channel invert shall be three to six inches below the invert of the incoming sewers. To prevent jetting action, the length and construction of the screen channel shall be adequate to reestablish hydraulic flow pattern following the drop in elevation.

3. Multiple channels, where provided, shall be equipped with the necessary gates to isolate flow from any one screening unit operation. Provisions shall also be made to facilitate dewatering each unit. The channel preceding and following the screen shall be shaped to eliminate settling and accumulation of solids. Fillets may be necessary.

E. Screening management. Properly sized facilities shall be provided for removal, storage, and disposal of screenings as required by the approved operation and maintenance manual or sludge management plan. Manually cleaned screening facilities shall include an accessible platform, in accordance with VOSH requirements, from which the operator may remove screenings easily and safely. Suitable drainage facilities shall be provided both for the platform and for storage areas, with all drain water returned to the raw or primary influent flow.

F. Comminution. Comminution should be provided in treatment works that do not provide primary sedimentation, unless other means of protecting downstream processes and equipment are provided. The term "comminutors" shall be understood to also include barminutors, or other shredding/grinding equipment.

1. Comminutors should be located downstream of any grit removal equipment. Areas containing comminution devices shall be provided with stairway access, adequate lighting and ventilation in accordance with VOSH requirements and convenient and adequate means for maintenance and device removal. Comminutors installed in a building where other equipment or offices are located should be accessible only through a separate outside entrance. Comminutor capacity shall be adequate to handle expected peak flows.

2. A bypass channel with appropriate screening shall be provided. Gates to isolate flow from the comminutor channel shall be installed. Each comminutor not preceded by grit removal shall be protected by a screen, trap, or other means to remove potentially harmful gravel.

3. Electrical equipment in comminutor chambers is to be designed in accordance with the applicable requirements of the National Electrical Code. Protection against accumulation of hazardous gases and accidental submergence shall be provided as required by state and federal regulations.

9 VAC 25-790-510. Grit removal facilities.

A. Grit removal unit operations facilities shall be provided for all sewage treatment works with a design capacity of 0.15 million gallons per day or greater and are required for treatment works receiving sewage from combined sewers or from sewer systems receiving substantial amounts of grit. Grit removal facilities should be provided at all sewage treatment works.

1. Grit removal facilities should be located ahead of pumps and comminuting devices. Coarse bar racks and other suitable screens should be placed ahead of mechanically cleaned grit removal facilities.

2. Treatment works treating wastes from combined sewers shall have at least two mechanically cleaned grit removal units, with provisions for unit bypassing.

3. A single manually cleaned or mechanically cleaned grit removal unit, with a unit bypass, is acceptable for those sewage treatment works with a design capacity of less than 0.15 million gallons per day and serving separate sanitary sewer systems.

4. Minimum facilities for larger treatment works serving separate sanitary sewers shall be at least one mechanically cleaned unit with a unit bypass.

B. Design. The design of grit removal facilities shall be based on the requirements of the downstream treatment units. Local conditions and wastewater characteristics shall be evaluated in selecting the design size of particle to be removed. Flow turbulence into and through grit removal basins shall be minimized.

1. Horizontal flow basins shall be designed so as to provide controlled velocities as close as possible to one foot per second during average design flow conditions. The detention period shall be based on the size of particle to be removed. The design should take into consideration hydraulic inefficiencies and positioning of inlets and outlets.

2. Aerated chambers shall be designed to provide a minimum detention time of three minutes at average flow. An air flow of three to five cubic feet per minute per foot of chamber length should be maintained. Aerated chambers shall have adequate and flexible controls for agitation and air supply devices.

3. Other types of degritters will be approved on a case-by-case basis upon evaluation of satisfactory performance data.

4. Wherever possible, grit removal facilities should be located in open areas with easy access. Grit removal facilities located in deep pits shall be provided with mechanical equipment for pumping or hoisting grit to ground level. Such pits shall have a stairway, elevator, or manlift, adequate ventilation, and adequate lighting in accordance with VOSH requirements.

5. Provisions shall be made for dewatering each unit. Drain lines shall discharge to points within the system such that maximum treatment of the contents of the drained unit is provided.

6. The provision of grit washing facilities shall be a function of the ultimate disposal and transportation methods provided for the grit. Impervious surfaces with drains shall be provided for grit handling areas. If grit is to be transported, conveying equipment shall be designed to avoid loss of material.

9 VAC 25-790-520. Pre-aeration.

Aeration of pretreated sewage should be provided whenever the low dissolved oxygen, or anaerobic condition, of the sewage can interfere with downstream unit operation reliability. Pre-aeration may be used to prevent solids deposition problems in on-line or off-line equalization or storage basins.

1. Pre-aeration unit operations shall be designed so that removal from service will not interfere with normal downstream operation of the remainder of the treatment process.

2. Inlet and outlet devices shall be designed to ensure proper distribution and help prevent solids deposition, while minimizing any hydraulic short circuiting effects.

3. The aeration equipment shall be capable of obtaining both adequate mixing and self-cleaning velocities within the basin. Any of the types of equipment used for aeration of biological reactors may be utilized.

4. A satisfactory means of grit removal shall be provided for operation of pre-aeration basins.

9 VAC 25-790-530. Clarifiers.

A. Conventional solids settling basin design information shall apply to clarifiers not preceded by chemical flash mix and flocculation. Where clarifiers are preceded by chemical flash mix and flocculation, chemical clarification requirements shall apply.

B. Design. Conventional clarifiers shall be designed to dissipate the inlet velocity, to distribute the flow uniformly across the basin, and to prevent short-circuiting hydraulic currents.

1. Inlet channels should be designed to maintain a velocity of at least one foot per second at 1/2 design flow. Corner pockets and dead ends shall be eliminated, and corner fillets or channeling used where necessary.

2. Provisions shall be made for elimination or removal of floating materials in inlet structures having submerged ports.

3. The minimum length of flow from inlet to outlet of a clarifier should be 10 feet unless special provisions are made to prevent short circuiting.

4. The liquid depth of mechanically cleaned clarifiers shall be as shallow as practicable but not less than 10 feet for an overflow rate of 300 gpd per square foot. For each three-foot increase or decrease in depth, the overflow rate shall be increased or decreased by 200 gpd per square foot respectively. Final clarifiers receiving flow from biological reactors should not be less than 12 feet in depth.

5. A minimum of two hours of average design flow detention volume should be provided within the settling zone of conventional clarifiers, at the design loading.

6. Multiple clarifiers capable of independent operation shall be provided at treatment works having a capacity of more than 40,000 gallons per day; however, single clarifiers may be allowed at Reliability Class II and Class III treatment works having a capacity up to 100,000 gpd when appropriate reliability and continuous operability requirements are satisfied.

7. Where multiple clarifiers are utilized in suspended growth processes, provisions for combining the effluent from the reactors (aeration basins) and proportionally distributing the reactor effluent to each clarifier shall be included, for the purpose of evenly distributing the biomass to the clarifiers.

8. Overflow weir plates shall be adjustable. In cases in which clarifier designs have a potential for short circuiting hydraulic inefficiencies, weir loadings rates should not exceed 10,000 gallons per day per linear foot for treatment works designed for average flows of 1.0 mgd or less. Special consideration will be given to weir loading rates for treatment works designed for flows in excess of 1.0 mgd, but such loading rates should not exceed 15,000 gallons per day per linear foot if short circuiting problems may affect performance. If pumping is required, pump capacity shall be related to clarifier design to avoid excessive weir loading.

9. The tops of beams and similar construction features which are submerged shall have a minimum slope of 1.4 vertical to 1 horizontal. The underside of such features should have a slope of one to one to prevent the accumulation of scum and solids. Effective scum collection and removal facilities, including baffling, shall be provided ahead of the outlet weirs on all clarifiers. Provisions may be made for discharge of scum with the sludge; other provisions may be necessary to dispose of floating materials which may adversely affect sludge handling and management.

10. Clarifier design should include provisions for reasonable access for maintenance and protection of operators. Such features may include slip resistant stairways and walkways, protective handrails, etc., in accordance with VOSH requirements. If side walls are extended some distance above the liquid level to provide flood protection, or for other purposes, stairs and walkways with handrails should be provided to facilitate housekeeping and maintenance. Access for cleaning and maintenance of weirs should also provide proper safety features in accordance with VOSH requirements.

11. Where primary clarifiers are used, provisions for emergency bypassing, or discharging sewage which has received preliminary treatment directly to the biological treatment unit operation, may be desirable.

12. Shallow depth sedimentation will be considered on a case-by-case basis.

C. Loadings. Conventional clarifier design should provide for established surface settling rates (flow rate per unit surface area) for optimum performance reliability.

1. Surface settling rates for primary clarifier should not exceed 1,000 gpd per square foot at design average flows or 2,500 gpd per square foot at peak hourly flows. Clarifier sizing shall be calculated for both flow conditions, and the larger surface area shall be used.

2. Surface settling rates for secondary clarifiers following attached growth biological reactors shall not exceed 1,200 gpd per square foot, based on peak hourly flows, or 500 gpd per square foot, based on average daily design flow, whichever loading results in a larger clarifier volume.

3. The hydraulic design of clarifiers following the activated sludge process shall be based on the anticipated peak hourly overflow rate from the clarifier. The hydraulic loading, except as noted, shall not exceed the following peak hourly surface settling (overflow) rates:

Type of Process	Rate
conventional	1,200 gpd/sq. ft.
step aeration	1.200 gpd/sq. ft.
contact stabilization	1,200 gpd/sq. ft.
carbonaceous stage of separate stage nitrification	1,200 gpd/sq. ft.
extended aeration	1,000 gpd/sq. ft.
nitrification stage of separate stage nitrification	800 gpd/sq. ft

4. The peak hour surface settling (overflow) rates for sewage treatment works with an average design flow of 0.1 mgd or less shall not exceed 800 gpd/sq. ft.

5. The established surface settling rates may be reduced by up to 30% for treatment works employing flow equalization, prior to the clarifier, provided that such a reduction will not result in turbulence and density currents that may be associated with a smaller clarifier design surface area.

6. The solids loading shall be evaluated at both peak hourly and average daily flow conditions in the design of secondary clarifiers, for comparison to the hydraulic loading. The larger surface area established by design loadings shall be utilized to establish the required clarifier size. The following values for solids loading shall apply:

Type of Treatment	Solids loading (lb/sq. ft./hour)	
	Average	Peak
attached growth process	0.6-1.0	1.6
extended aeration	0.20-1.0	1.4
other activated sludge	0.6-1.25	1.8

D. Sludge removal and handling. Sludge collection and sludge withdrawal facilities shall be designed to minimize density currents and to permit rapid and continuous sludge removal.

1. Final clarifiers in activated sludge treatment works greater than 0.25 mgd shall be provided with positive scraping devices.

2. If multiple sludge hoppers are provided for sludge collection, means for individually and variably controlling sludge withdrawal from each hopper shall be provided in order to overcome any variations in the quantities of settled sludge in the various hoppers.

3. Each sludge withdrawal line shall be individually valved. Pumped withdrawal lines shall be at least four inches in diameter, and gravity withdrawal lines shall be at least six inches in diameter. The size of sludge withdrawal lines for airlift sludge removal shall be determined by the sludge removal rate.

4. The depth or head available for gravity withdrawal of sludge shall be at least 30 inches of water. A sludge well or other appropriate equipment shall be provided for viewing and sampling the sludge.

5. The minimum slope of the hopper side walls for primary basins shall be 1.7 vertical to 1.0 horizontal. Hopper wall surfaces should be made smooth with rounded corners to aid in sludge removal. Hopper bottoms should have a maximum dimension of two feet. The use of sludge hoppers for sludge thickening purposes is not recommended.

Article 5.
Sludge Processing and Management.

9 VAC 25-790-540. Sludge stabilization.

The selection and operation of the sludge treatment or stabilization process shall be based on the ultimate utilization of the final sludge product. Land based management of treated sewage sludge may require the production of biosolids as described in the Biosolids Use Regulations (12 VAC 5-585). The design requirements for the treatment and stabilization processes described in this chapter are based on the assumption that they must accomplish the necessary processing of sewage sludge at the treatment works. Consideration will be given to reducing design requirements, on a case-by-case basis, for treatment works employing series operation of two or more stabilization processes or methods in accordance with the means of sludge management.

9 VAC 25-790-550. Anaerobic digestion.

A. The design of anaerobic digesters should provide an optimum environment for effective microbial degradation of the organic matter in sewage sludge. The digester system design shall address separation and removal of liquid or supernatant. The production of methane gas (CH_4) should be optimized. Digester gas should be utilized as a fuel whenever practical.

B. Design. A minimum of two anaerobic digesters, or enclosed reactors, shall be provided, so that each digester may be used as a first stage or primary reactor for treating primary and secondary sludge flows generated at a treatment works with a design flow exceeding 0.5 mgd.

1. Where multiple digesters are not provided, a storage facility or adequate available sludge processing system shall be provided for emergency use so that the digester may be taken out of service without unduly interrupting treatment works operation.

2. Each digester should have the means for transferring a portion of its contents to other digesters. Multiple digester facilities should have means of returning supernatant from the settling digester unit to appropriate points for treatment.

3. Provisions for side-stream treatment of supernatant shall be included when the supernatant load is not included in the treatment works design.

4. Multiple sludge inlets and draw-offs and multiple recirculation section and discharge points (minimum of three) to facilitate flexible operation and effective mixing of the digester contents shall be provided. One inlet shall discharge above the liquid level and be located at approximately the center of the digester to assist in scum breakup. Raw sludge inlets should be so located as to minimize short circuiting between the inlets and either the supernatant draw-off, or sludge withdrawal points.

5. The proportion of depth to diameter should provide for a minimum of six feet storage depth for supernatant liquor, or the proportion of total volume allocated for supernatant should be 10% or more.

6. The digester bottom shall slope to drain toward the withdrawal pipe. At least one access manholes shall be provided in the top of the digester in addition to the gas dome. One opening shall be large enough to permit the use of mechanical equipment to remove grit and sand. A separate side wall manhole shall be provided at the basin floor level.

a. To facilitate emptying, cleaning, and maintenance, the digester design shall provide for access and safety features.

b. In accordance with VOSH requirements and these regulations, the operation and maintenance manual should specify: nonsparking tools, rubber soled shoes, safety harness, gas detectors for inflammable and toxic gases, and at least one self contained breathing apparatus.

C. Loadings. Where the composition of the sewage has been established, digester capacity shall be computed from the volume and character of sludge to be digested. The total digestion volume shall be determined by rational calculations based upon such factors as volume of sludge added, its percent solids and character, the temperature to be maintained in the digesters, the degree or extent of mixing to be obtained, expected formation of inactive deposits, and the size of the installation with appropriate allowance for sludge and supernatant storage. These detailed calculations shall be submitted to justify the basis of design.

1. The design average detention time for sludge undergoing digestion for stabilization shall be a minimum of 15 days within the primary digester, but longer periods may be required to achieve the levels of pathogen control and vector attraction reduction necessary for the method used for sludge management.

2. The digester shall be capable of maintaining a minimum average sludge digestion temperature of 35°C (95°F) with the capability of maintaining temperature control within a 4°(+/-)C range.

3. If unheated digesters are utilized, they shall have the capacity to provide a minimum detention time of 60 days within the digestion volume in which sludge is maintained at a temperature of at least 20°C (68°F).

4. For digestion systems where mixing is accomplished only by circulating sludge through an external heat exchanger, the system shall be loaded at less than 40 pounds of volatile solids per 1,000 cubic feet of volume per day or at a volumetric rate that provides not less than a 30 day detention time in the active digestion volume. The design volatile solids loading should be established in accordance with the degree of mixing provided.

5. Where mixing is accomplished by other methods, loading rates shall be determined on the basis of information furnished by the design consultant.

D. Completely mixed systems. For digesters providing for intimate and effective mixing of the digestion volume contents, the systems shall be designed for an average feed loading rate of less than 200 pounds of volatile solids per 1,000 cubic feet of volume per day or at a volumetric loading that provides 15 days or more detention time in the active digestion volume.

1. Confined mixing systems include (i) arrangements where gas or sludge flows are directed through vertical channels; and (ii) mechanical stirring, or pumping systems. Both confined mixing and unconfined continuously discharging gas mixing systems shall be designed to ensure complete turnover of digestion volume every 30 minutes. For tanks over 60 feet in diameter, multiple mixing devices shall be used.

2. Unconfined, sequentially discharging gas mixing systems shall be designed using the number of discharge points and gas flow rates shown for the various tank diameters as listed in this section, unless sufficient operating data is submitted and approved to verify the performance reliability of a alternative designs.

3. Gas discharge lines (lances) mounted on a floating cover or top designed to accumulate gas emissions shall extend to the base of the vertical side wall while the cover is resting on its landing brackets. For floor mounted diffuser boxes or lances mounted to a fixed cover, gas discharge shall extend to the base of the vertical side wall.

DESIGN CRITERIA FOR MULTIPLE DISCHARGE MIXING SYSTEMS, SEQUENTIAL DISCHARGE

Maximum Diameter (Ft.)									
Tank Diameter	20-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	101-110
(Minimum Number of Points)									
Discharge Points	4	5	6	7	8	9	10	11	12
Minimum Gas Flow									
Gas Flow (CFM)	95	95	95	150	150	150	200	250	300

4. The minimum gas flow supplied for complete mixing shall be 15 cubic feet/min./1000 cubic feet of digestion volume. Flow measuring devices and throttling valves shall be used to provide the minimum gas flow.

5. The design power supplied for mechanical stirring or pumping type complete mixing systems shall be capable of achieving a minimum of 0.5 horsepower per 1,000 cubic feet of digestion volume.

6. Where low speed mechanical mixing devices are specified, more than one device shall be provided unless other mixing devices are also provided.

E. Gas collection. All portions of the gas system, including the space above the liquid surface in the digester, storage facilities and piping shall be so designed that under all normal operating conditions, including sludge withdrawal, the gas will be maintained under positive pressure.

1. All enclosed areas where any gas leakage might occur shall be adequately ventilated.

2. All necessary safety facilities should be included where gas is produced in accordance with VOSH requirements.

3. Pressure and vacuum relief valves and flame traps, together with automatic safety shut-off valves, may be provided.

4. Water seal equipment shall not be installed on gas piping.

5. Gas piping shall be of adequate diameter to provide a velocity less than 12 feet per second at a flow of two times the average rate and shall slope to condensation or drip traps at low points.

6. The use of float controlled condensate traps is not permitted. Condensation traps shall be placed in accessible locations for daily servicing and draining.

7. Electrical fixtures and equipment located in enclosed places where gas may accumulate will be evaluated in accordance with the National Board of Fire Underwriters' specifications for hazardous conditions and other applicable codes and regulations.

8. The electrical equipment provided in sludge-digester pipe galleries containing gas piping should be designed and installed to eliminate potential explosive conditions. The design of electrical equipment located in any location where gas or digested sludge leakage is possible will be evaluated in accordance with applicable codes and regulations.

9. Waste gas burners shall be readily accessible and should be located at least 50 feet away from any structure, if placed at ground level. Gas burners may be located on the roof of the control building if sufficiently removed from the digester and gas storage tank and will comply with all applicable state and federal air pollution control requirements. Waste gas burners shall not be located on top of the digester or gas storage tank.

10. In remote locations it may be permissible to discharge small quantities of digester gas (less than 100 CFH) to the atmosphere through a return bend screened vent terminating at least 10 feet above the walking surface, provided the assembly incorporates a flame trap and is in compliance with all applicable state and federal regulations.

11. A gas meter with bypass shall be provided to meter total gas production. Gas piping lines for anaerobic digesters shall be equipped with closed type indicating gauges. These gauges shall read directly in inches of water. Normally, three gauges will be provided: (i) one to measure the main line pressure; (ii) a second to measure the pressure to gas-utilization equipment; and (iii) the third to measure pressure to waste burners. Gas tight shut-off and vent cocks shall be provided. The vent piping shall be extended outside the building, and the opening shall be screened and arranged to prevent the entrance of rainwater. All piping of the manometer system shall be protected with safety equipment.

12. Any underground enclosures connecting with anaerobic digester tanks or containing sludge or gas piping or equipment shall be provided with forced ventilation in accordance with VOSH requirements and this chapter and standards contained in this chapter. Tightly fitting, self closing doors shall be provided at connecting passageways and tunnels to minimize the spread of gas.

F. Energy control. If practical, digesters should be constructed above the water table and should be suitably insulated to minimize heat loss. The use of digester gas as a heating fuel source is encouraged.

1. Sludge shall be heated by circulating the sludge through external heaters unless effective mixing is provided. Piping shall be designed to provide for the preheating of feed sludge before introduction to the digesters. Provisions shall be made in the layout of the piping and valving to facilitate cleaning of these lines. Heat exchanger sludge piping shall be sized for design heat transfer requirements.

2. Sufficient heating capacity shall be provided to maintain consistently the design temperature required for sludge stabilization. For emergency usage, an alternate source of fuel shall be available and the boiler or other heat source shall be capable of using the alternate fuel.

3. The heating system design shall provide for all controls necessary to ensure effective and safe operation. Facilities for optimizing mixing of the digester contents for effective heating shall be provided.

4. Sludge heating devices with open flames should be located above grade in areas separate from locations of gas production or storage.

G. Supernatant handling. Supernatant withdrawal piping shall not be less than six inches in diameter, and piping shall be arranged so that withdrawal can be made from three or more levels in the tank. A positive, unvalved, vented overflow shall be provided.

1. On fixed cover digesters the supernatant withdrawal level should preferably be selected by means of interchangeable extensions at the discharge end of the piping.

2. If a supernatant selector is provided, provision shall be made for at least two other draw-off levels located in the supernatant zone of the digester in addition to the unvalved emergency supernatant draw-off pipe. High pressure backwash facilities shall be provided.

3. Provisions shall be made for sampling at each supernatant draw-off level. Sampling pipes shall be at least 1-1/2 inches in diameter.

4. Management of digester supernatant must be addressed in the treatment works design. Also, sidestream treatment alternatives for digester supernatant shall be considered in the preliminary engineering design.

9 VAC 25-790-560. Aerobic sludge digestion.

A. Aerobic sludge digestion reactors shall be designed for effective mixing and aeration. If diffusers are used, they shall be of the type that minimizes clogging and they should be designed to permit removal for inspection, maintenance and replacement without dewatering the tanks.

B. Design. Multiple aerobic digesters are required at all treatment works having a design flow capacity of more than 0.5 mgd. The size and number of aerobic sludge digesters shall be determined by rational calculations based upon such factors as (i) volume of sludge added; (ii) type and percent solids; (iii) the required volatile solids reduction for stabilization; (iv) allowance for sludge and supernatant storage; and (v) the minimum design temperature of the digester contents.

1. Calculations shall be submitted to justify the design and shall include design digester temperature based on the type of mixing equipment and other factors.

2. Digester volume shall be a minimum of 20% of the average design flow of the treatment works. The design digester volume should be increased up to 25% of the average design flow if the wastewater temperature will remain below 10°C (50°F) for an extensive period of time (60 days/year).

3. A reduction in requirements for hydraulic detention time may be given for treatment works designed to be operated in the extended aeration mode, or coupled with additional stabilization processes, or operated at elevated temperatures.

4. Facilities shall be provided for effective separation and withdrawal, or decanting of supernatant.

C. Loadings. The volatile solids loading should be in the range of one- to two-tenths (0.1 to 0.2) pounds of volatile solids per cubic foot per day.

1. Dissolved oxygen concentration maintained in the liquid shall be in the range of one to two milligrams per liter.

2. Energy input requirements for mixing should be in the range of 0.5 to 1.5 horsepower per 1,000 cubic feet, where mechanical aerators are utilized, and 20 to 30 standard cubic feet per minute per 1,000 cubic feet of aeration tank, where air mixing is utilized.

9 VAC 25-790-570. Composting.

A. Conventional sludge composting facilities aerobically process digested, or otherwise treated, sewage sludge that is uniformly mixed with other organic materials and bulking agents to facilitate biological decomposition of organics. The treated sewage sludge will be exposed to temperatures at or above 55°C for three consecutive days or more. The method of mixing and aeration, and the carbon to nitrogen characteristics, of the compost mix are critical to the process design.

B. General design. Unless the facility is totally enclosed, an appropriate buffer shall be established on a case-by-case basis by considering both the locations of any residential area, hospitals, nursing homes for the elderly and serum production centers and the prevailing wind at such locations. Local jurisdictions impacted by this restriction shall be so notified.

1. All compost facilities shall be provided with adequate means to prevent and control odors as necessary.

2. All compost facilities shall be provided with all-weather roads to and from the facility, as well as between the various process operations.

3. The receiving, mixing, composting, curing, drying, screening, and storage areas shall be paved with asphaltic concrete, reinforced concrete, or other impervious, structurally stable material that provides similar site characteristics.

4. The facility shall be graded to prevent uncontrolled runoff and a suitable drainage system shall be provided to collect all process wastewater and direct it to storage and treatment facilities. Process wastewater includes water collected from paved process areas. The capacity of the drainage system, including associated storage or treatment works system shall be based on the 24-hour rainfall of a 10-year return frequency.

5. All facility process wastewater and sanitary wastewater shall be collected and treated prior to discharge.

C. Facilities. A weigh scale, volumetric method, or other means shall be provided for determining the amount of sludge or residuals delivered to the facility and the amount of compost material removed from the facility. Adequate space and equipment must be provided for mixing operations and other material handling operations.

1. Where liquid, or dewatered, sludge or residuals are processed by the compost facility, all receiving of such inputs shall occur in either:

a. An area that drains directly to a storage, treatment, or disposal facility.

b. A handling area which shall be hard-surfaced and diked to prevent entry of runoff or escape of the liquids.

c. A sump with an adequately sized pump located at the low point of the hard-surfaced area shall be provided to convey spills to a disposal or holding facility.

2. Provisions for cleaning all sludge transport or residual hauling trucks that return to public roads, shall be provided at all compost facilities. The facility shall be capable of effective operation regardless of weather conditions. Wash water shall be collected for necessary treatment.

3. At all compost facilities handling liquid or dewatered residual materials that must be mixed prior to composting, a mixing operation shall be provided. The operation shall have sufficient capacity to properly process the peak daily waste input with the largest mixer out of operation. Volumetric throughput values used to establish necessary mixing capacity may be based on the material volume resulting from the sludge to bulking agent ratio, or may be estimated from previous experience or pilot scale tests.

4. Effective mixing equipment should be provided for use at all compost facilities. The ability of all selected equipment to produce a compostable mix from sludge of an established moisture content, residual material, and the selected bulking agent shall be documented from previous experience or pilot tests.

5. Except for windrow composting wherein mobile mixers are used, an area with sufficient space to mix the bulking agent and sludge or residuals and store half of the daily peak input shall be provided. The mixing area shall be covered to prevent ambient precipitation from directly contacting the mix materials.

6. Where conveyors are used to move the compost mix to the composting area and or help provide mixing, either sufficient capacity shall be provided to permit handling of the mix with one conveyor out of operation, or a backup method of handling or storing shall be provided. Runoff shall be directed to a storage or treatment facility. Capacity of the drainage system shall be based on the 24-hour rainfall producing a peak rate expected once in 10 years.

D. System design. The system design shall be sufficient to provide the level of treatment required for protection of public health and welfare in relation to the anticipated management method. Consideration should be given to covering the compost mixing pad and curing area in order to allow for handling of bulking agents and treated sludge and the finished compost, during extended periods of precipitation. If a roof type cover is not provided, operation of the facility during critical weather periods shall be addressed. Sufficient equipment shall be provided for routinely measuring the temperature and oxygen at multiple points and depths within the compost piles.

1. Windrow method. The area requirements shall be based on the average daily compost mix inputs, a minimum detention time of 30 days on the compost pad, and the area required for operation of the mixing equipment. Sufficient compost mix handling equipment shall be provided to turn the windrows daily. In addition, proper drainage and space shall be provided to allow equipment movement between compost pile sections and access around the working areas.

2. Aerated-static pile method. The aerated-static pile area requirement shall be based on the average daily compost mix inputs, along with storing base and cover material, with a composting time of 21 days, unless the applicant can demonstrate through previous experience or pilot scale studies that less time is necessary to achieve the requirements.

a. The compost mix pile shall be provided with a means of uniformly distributing air flow. One foot or more thick base of friable material may be utilized under the deepest sections of compost mix. A 1-1/2 foot or more thick covering blanket of unscreened compost or a one foot thick or more blanket of screened compost may be utilized over the compost mix pile.

b. Compost mix piles should be configured to provide adequate aeration of the mix using either positive or negative pressure for air flow through the piles.

3. Confined composting methods. Due to the large variation in composting processes, equipment types, and process configuration characteristic of currently available confined systems, such as enclosed operations or in-vessel systems, it is not feasible to stipulate specific design criteria. However, a confined composting system will not be approved unless the applicant can demonstrate, through previous operating experience or pilot scale studies, that the material removed from the enclosed container or compost process, after the manufacturer's suggested residence time, has an equivalent or higher degree of stabilization than would be achieved after 21 consecutive days of aerated static pile composting.

E. Aeration. Sufficient blower capacity shall be provided to deliver the necessary air flow through the compost mix, but the delivered air flow shall not be less than a minimum aeration rate of 500 cubic feet per hour per dry ton (CFH/DT). Where centralized aeration is utilized, multiple blower units shall be provided and shall be arranged so that the design air requirement can be met with the largest single unit out of service. Where individual or separated blowers are used, sufficient numbers of extra blowers shall be provided so that the design air requirement can be met with 10% of the blowers out of service. For facilities that are not continuously manned, the blower units should be equipped with automatic reset and restart mechanisms or alarmed to a continuously manned station, so that they will be placed back into operation after periods of power outage.

1. Each pile aeration distribution header shall be provided with a throttling control valve. The aeration system shall be designed to permit both suction and forced aeration. The piping system shall be capable of delivering 150% of the design aeration rate. The aeration piping may be located in troughs cast into the compost pad.

2. The aeration system shall be designed to permit the length of the aeration cycle to be individually adjusted at each pile header pipe.

F. Compost handling. The design of the curing area shall be based on a minimum retention time of 30 days unless the applicant can demonstrate through previous experience or pilot studies that less time is required. Daily input shall be based on the average daily input of mix to the composting area.

1. A drying stage is optional, but is usually required if compost is to be recycled as a bulking agent or if screening is required. Consideration should be given to covering the drying area. If a cover is provided, it can be designed so that sunlight is transmitted to the composting materials while preventing direct contact with ambient precipitation. Efficient drying may be accomplished by drawing or blowing air through the compost mixture or by mechanical mixing of shallow layers with stationary bucket systems, mobile earth moving equipment, or rotating discs.

2. Screening shall be provided for all compost facilities where the compost disposition necessitates the use of a screened product or where the bulking agent must be recycled and reused.

a. A daily screening capacity of 200% of the average daily amount of compost mix shall be provided when screening is required.

b. Based on previous composting facility performance, or on pilot tests, the ability of the specified equipment to screen compost at the projected moisture range shall be demonstrated.

c. The area used for screening should be covered unless operations are not hindered when screening is temporarily discontinued.

3. Storage areas shall be provided for six months storage of compost unless the applicant can demonstrate (through previous experience, pilot studies or letters of intent to accept compost offsite) that less storage area is required.

For all compost facilities where a separate bulking agent is required, storage area for a six-month supply of the bulking agent shall be provided, unless the applicant can demonstrate that bulking agent supplies can be replenished more frequently.

9 VAC 25-790-580. Heat treatment.

A. The design of heat treatment systems shall be based on the anticipated sludge flow rate (gpm) with the required heat input dependent on sludge characteristics and concentration. The system should be designed for continuous 24-hour operation to minimize additional heat input to start up the system. Measures for the adequate control of odors shall be stipulated for review.

B. Design. Multiple units shall be provided unless nuisance-free storage or alternate stabilization methods are available, to avoid disruption to treatment works operation when units are not in service. If a single system is provided, standby grinders, fuel pumps, air compressor (if applicable), and dual sludge pumps shall be required.

1. A reasonable downtime for maintenance and repair based on data from comparable facilities shall be included in the design. Adequate storage for process feed and downtime shall be included. Control parameters shall be adequately monitored. Continuous recorders to monitor temperatures shall be provided.

2. Due to the large variation in incineration processes, equipment types, and configurations characteristic of currently available incineration systems, it is not feasible to stipulate specific design criteria. Therefore, these systems shall be considered on a case-by-case basis. Design of these systems should be based on pilot plant studies or data from comparable facilities.

C. Features. The process should provide heat stabilization in a reaction vessel within a range of 175°C or 350°F for 40 minutes to 205°C or 400°F for 20 minutes at pressure ranges of 250 to 400 psig, or provide for pasteurization at temperatures of 30°C or 85°F or more and gage pressures of more than one standard atmosphere (14.7 psia) for periods exceeding 25 days.

1. Sludge grinders shall be provided to protect heat exchangers from rag fouling. An acid wash or high pressure water wash system shall be available to remove scale from heat exchangers and reactors. Materials of construction of heat exchangers shall be selected to minimize corrosion.

2. The decant tank shall be equipped with a sludge scraper mechanism and shall be covered to prevent odor release.

3. Separate, additional grit removal (in addition to grit removal at the treatment works influent) should be considered to prevent abrasion of piping.

4. Adequate treatment works or sidestream treatment shall be provided for the recycle streams from heat treatment.

5. Odor control shall be addressed for exhaust and off-gas from decant tanks in accordance with state and federal air pollution control requirements.

9 VAC 25-790-590. Chemical treatment.

A. The fundamental design areas to be considered include chemical feeding, mixing, and storage capacity. Chemical treatment operation controls may include pH, contact time and mixture temperature.

B. Alkaline treatment. The alkaline additive dosage required to stabilize sludge is determined by the type of sludge, its chemical composition and the solids concentration. Performance data taken from pilot plant test programs or from comparable facilities should be used in determining the proper dosage.

1. The design objective shall be to furnish uniform mixing in order to maintain a pH of 12 or above for two hours or more in the alkaline additive-sludge mixture. The design criteria for accomplishing adequate treatment may include:

a. Adding a controlled dosage of alkaline agents to sludge and providing uniform mixing of the sludge and agents.

b. Bringing the alkaline additive-sludge mixture pH to the design objective, such as a mixture pH of 12.5 or more and maintaining the mixture pH above 12.5 for 30 minutes or more.

c. Providing capacity to achieve a temperature of the alkaline-sludge mixture of more than 52°C, if desired, and maintaining a sufficient temperature over a measured contact period to ensure pasteurization.

d. Maintaining conditions so that the sludge is not altered or further distributed for two hours or more after alkaline treatment.

2. Multiple units shall be provided unless nuisance-free storage or alternate stabilization methods are available to avoid disruption to treatment works operation when units are not in service. If a single system is provided, standby conveyance and mixers, backup heat sources, dual blowers, etc., shall be provided as necessary. A reasonable downtime for maintenance and repair based on data from comparable facilities shall be included in the design. Adequate storage for process, feed, and downtime shall be included.

3. Storage facilities and chemical handling shall be designed in accordance with this chapter. Either mechanical or aeration agitation should be provided to ensure uniform discharge from storage bins. Alkaline additive feeding equipment shall meet the requirements of this chapter. Hydrated lime should be fed as a 6% to 18% $Ca(OH2)$ slurry by weight. Other suitable means should be developed for controlling the feed rate for dry additives.

4. The additive/sludge blending or mixing vessel shall be large enough to hold the mixture for 30 minutes at maximum feed rate. In a batch process, a pH greater than 12 shall be maintained in the mixing tank during this period. In a continuous flow process, the nominal detention time (defined as tank volume divided by volumetric input flow rate) shall be used in design, and a pH greater than 12 shall be maintained in the exit line. Slurry mixtures can be mixed with either diffused air or mechanical mixers. Mixing equipment shall be designed to keep the alkaline slurry mixture in complete suspension.

5. Coarse bubble diffusers should be used for mixing with compressed air. A minimum air supply of 20 scfm per 1,000 cubic feet of tank volume should be provided for adequate mixing. The mixing tank shall be adequately ventilated and odor control equipment shall be provided.

6. Mechanical mixers should be sized to provide 5 to 10 HP per 1,000 cubic feet of tank volume. Impellers should be designed to minimize fouling with debris in the sludge.

7. Pasteurization vessels shall be designed to provide for a minimum retention period of 30 minutes. The means for provision of external heat shall be specified.

C. Chlorine treatment. The stabilization of sludge by high doses of chlorine should be considered on a case-by-case basis. Process equipment that comes into contact with sludges that have not been neutralized after chlorine oxidation shall be constructed of acid resistant materials or coated with protective films. Caution should be exercised with recycle streams from dewatering devices or sludge drying beds which have received chlorine stabilized sludge due to the creation of potential toxic byproducts which may be detrimental to the treatment process or receiving stream.

D. Other treatment. Other processes for chemical treatment can be considered in accordance with this chapter.

9 VAC 25-790-600. Sludge thickening.

A. Sludge thickening to decrease the liquid fraction should be considered for volume reduction and conditioning of sludges prior to treatment and management. Biological sludges returned to reactors should be thickened to provide for effective control of biomass.

B. General design. Thickener design shall provide adequate capacity to meet peak demands. Thickeners should be designed to prevent septicity during the thickening process.

1. A sludge handling bypass around the thickening process is required. Dual units or alternate storage is required for all treatment works of greater than 1 mgd capacity.

2. Thickeners shall be provided with a means of continuous return of supernatant for treatment. Provisions for side-stream treatment of supernatant should be considered.

3. Consideration should be given to any potential treatment advantages obtained from the blending of sludges from various treatment processes.

4. Odor control shall be addressed with consideration being given to flexibility of operations and changes of influent sludge characteristics.

C. Gravity systems. Clarifiers or gravity thickeners sufficiently sized for clarification will provide for thickening. However, the use of mechanical stirring devices will significantly improve the performance of gravity thickeners. Mechanical thickeners employ low speed stirring mechanisms for continuous mixing and flocculation within the zone of sludge concentration. In this manner, liquid separation is enhanced.

1. Conventional overflow rates for gravity thickeners should be in the 400-800 gpd per square foot range. The engineer shall provide the basis and calculations for the nonconventional surface loading rates. The side water depth of conventional gravity thickeners shall be a minimum of 10 feet. Circular thickeners shall have a minimum bottom slope of 1-1/2 inches per radial foot.

2. A gravity sludge thickener shall be so designed as to provide for sludge storage, if sufficient storage is unavailable within other external tankage. Sludge withdrawal from gravity thickeners should be controlled and adjusted, and variable speed pumps should be provided.

3. Gravity thickeners should be provided with bottom scraping equipment to enhance sludge removal. The scraper mechanism peripheral velocity should be in the 15 to 20 feet per minute range.

a. The scraper mechanical train shall be capable of withstanding extra heavy torque loads. The normal working torque load shall not exceed 10% of the rated torque load.

b. A method to correct blockage of the scraper mechanism and restore operation from a stalled position should be provided in accordance with the Operation and Maintenance Manual.

4. Alternative designs should be based on data obtained from a pilot plant (relatively small scale test equipment) program. Chemical addition and dilution water feed systems should be evaluated for use to optimize performance.

D. Dissolved air flotation. Dissolved air flotation (DAF) basins shall be equipped with bottom scrapers to remove settled solids and surface skimmers to remove the float established through release of pressurized air into the sludge inflow. The bottom scraper should function independently of the surface skimmer mechanism. Dissolved air flotation units should be enclosed in a building. A positive air ventilation system and odor control shall be provided.

1. Conventional design parameters include:

a. Maximum hydraulic loading rates of 2.0 gallons per minute per square foot of surface area (gal/min/sq. ft.).

b. A solids loading rate in the range of 0.4 to 1.0 pounds per hour per square foot of surface area (lb/hr/sq. ft.) without chemical addition. A solids loading rate of up to 2.5 lbs./hr./sq. ft. may be used if appropriate chemical addition is provided (9 VAC 25-790-860).

c. An air supply to sludge solids weight ratio in the range of 0.02 to 0.04.

2. The recycle ratio should be in the 30% to 150% range. The recycle pressurization system should utilize DAF effluent or secondary effluent if use of potable water is not available. The retention tank system shall provide a minimum pressure of 40 psig.

3. A polymer feed system shall be provided. The feed system shall meet the requirements of this chapter.

4. Alternative design should be based on data obtained from a pilot plant test program if sufficient operational performance data is not available.

5. Skimmer design shall be multiple or variable speed such as to allow normal operation in the less than one fpm range, with the capability of a speed increase to 25 fpm.

E. Mechanical separation. Filters or centrifuge can be used to thicken sludges. The process shall be preceded by pretreatment to remove material that can plug the media, nozzles or cause excessive wear.

1. Provisions for the addition of appropriate coagulants to the sludge inflow to the filter or centrifuge shall be considered.

2. The design basis and calculations for nonconventional loading rates shall be submitted for evaluation.

3. Filtrate or centrate shall be returned to the head of the primary units, aeration basins, or a separate side-stream treatment system.

9 VAC 25-790-610. Sludge dewatering.

A. Gravity drying beds, centrifuges, and various filtration equipment can be used to remove liquid from treated sewage sludge in order to reduce the amount of sludge that is to be managed. Drainage from beds and centrate or filtrate from dewatering units shall be returned to the sewage treatment process at appropriate points preceding disinfection. These organic loads shall be considered in treatment works design, and alternatives for handling these loads may be considered similar to those for thickening and treatment supernatant. The design of dewatering equipment used for municipal sludges containing significant industrial waste shall consider the release of constituents such as free metals, organic toxicants, or strong reducing/oxidizing compounds, especially when thermal or chemical stabilization processes are employed.

B. Capacity. Where mechanical dewatering equipment is employed, at least two units shall be provided unless adequate storage (separate or in-line) or an alternative means of sludge handling is provided. Whenever performance reliability and sludge management options are dependent on production of dewatered sludge, each of the mechanical dewatering equipment provided should be designed to operate for less than 60 hours during any six day period. The facility shall be able to dewater in excess of 50% of the average design sludge flow with the largest unit out of service. The requirements for excess capacity will depend upon the type of equipment provided, peak sludge factor, and storage capability not otherwise considered. All units shall have bypass capability for maintenance.

1. Where mechanical dewatering equipment will not be operated on a continuous basis and the treatment works is without digesters with built-in short-term storage, separate storage shall be provided.

2. In-line storage of stabilized or unstabilized sludge shall not interfere with the design function of any of the treatment unit operations. Separate sludge storage from primary digestors shall be aerated and mixed as necessary to prevent nuisance conditions. The effect of storage on the sludge dewatering characteristics shall be considered.

3. All dewatering facilities should be properly ventilated to protect operator personnel in accordance with VOSH requirements and this chapter and standards contained in this chapter. The potential for odors or obnoxious gases being released within or without the building and grounds and the control of such should be addressed in accordance with applicable state and federal requirements.

Sampling stations before and after each dewatering unit or any appropriate segment of the unit shall be designed to allow the periodic evaluation of the dewatering process.

C. Conditioning. Adequate mixing time for the dispension of reaction between the chemical or other additives shall be provided. Subsequent handling should avoid floc shearing. The injection or addition point should be carefully considered in relation to downstream equipment and to the combined effect of other additives. Chemical handling shall be in accordance with this chapter.

1. Solution storage or day tanks should provide for the design dosages, if the equipment design does not require continuous operation. A minimum of eight hours storage shall be provided unless the specific chemical or additive selected is adversely affected by storage. Storage for batch operations shall be adequate for one batch at maximum chemical or additive demand. Storage volume reductions shall be justified, and other methods to ensure a continuous supply of chemicals or additives through the operating day or batch shall be provided. If conditioning tanks are employed, mixers may be necessary and the design should consider the capability for variable detention times.

2. Pilot plant testing or full size performance data shall be utilized to determine the characteristics and design dosage of the additives. In-stream flocculation/coagulation systems design shall be supported by comparable performance data or pilot plant testing.

9 VAC 25-790-620. Sludge drying beds.

A. Actual performance data from similar facilities should be provided for bed sizing. If such data is unavailable, the following general guidelines shall been used as the minimum:

Stabilization Process	Loading Rate*
i. Anaerobic Digestion	20.0
ii. Aerobic Digestion and	15.0
iii. Other Stabilization Processes	15.0

*lbs dry solids/sq ft/year

B. Design. Area requirements for covered beds or greenhouse beds may be reduced if polymer is used to condition the sludge prior to application to the beds, or performance data from similar designs is provided. Covers should extend beyond the bed area sufficiently to keep out rain and snow.

1. Not less than two beds shall be provided and they shall be arranged to facilitate sludge removal. Concrete pads serving as vehicle support tracks should be provided for all percolation type sludge beds. Pairs of support tracks for percolation type beds should be on 20-foot centers.

2. Sludge drying beds should be rectangular and separated from adjacent beds by permanent or removable dividers. Bed width should be determined by a rational basis considering the sludge handling and treatment and sludge management options. If polymers or other chemicals are used to enhance sludge dewatering, the effects of the polymer dosage on uniform distribution of sludge on the bed shall be considered.

3. The sludge pipe to the beds shall terminate at least 12 inches above the surface and be arranged so that it will drain. Concrete splash plates shall be provided at sludge discharge points.

4. Interior walls shall be watertight and extend 15 to 18 inches above and at least 6 inches below the bed surface.

5. Exterior walls shall be watertight and extend 15 to 18 inches above the bed surface or ground elevation, whichever is higher. They shall extend 12 to 15 inches below the drain pipes.

6. The bottom of the drying bed shall be relatively impervious, consisting of a minimum of one-foot layer of clayey subsoil having a permeability of less than one-millionth (10^{-6}) cm/sec. In locations where the ground water table is within one foot of the bottom, a watertight concrete pad should be considered.

C. Media. The bed media top course shall consist of at least 12 inches of sand with a uniformity coefficient of less than 4.0 and an effective grain size between 0.3 and 0.75 millimeters. The bed media lower course shall consist of gravel around the underdrains that conforms to the Virginia Department of Transportation's Road and Bridge Specifications, 1974. The gravel layer should be 12 inches in depth, extending at least six inches above the top of the underdrains. It is desirable to place this gravel in two or more layers. The top layer of at least three inches shall consist of number 8 sized gravel ⅛ inch to ¼ inch in size and the bottom layer should consist of number 3 sized gravel.

1. Underdrains shall be clay pipe, concrete drain tile or other underdrain material acceptable to the department and shall be at least four inches in diameter and sloped not less than 1.0% to drain. Underdrains shall be spaced not more than 20 feet apart.

2. Vacuum assisted, wedgewire, or other variations to the gravity drying bed concept will be considered on a case-by-case basis. Actual performance data or pilot studies with appropriate scale-up factors shall be provided.

9 VAC 25-790-630. Filtration.

A. Rotary drums. The following rates of vacuum filtration, in pounds of dry solids per square foot of drum filter area per hour, for various types of sludge, may be considered conventional loading with proper prior sludge conditioning. A variable speed drive shall be provided.

Type of Treatment Process Producing Sludge Prior to Stabilization	Pounds of Dry Solids Per Square Foot Per Hour Minimum - Maximum
a. Primary	4 - 6
b. Primary and Contact Reactor	3 - 5
c. Primary and Suspended Growth Reactor	3 - 4

1. Unless dual trains are provided, the following appurtenant equipment shall be provided in duplicate with necessary connecting piping, and electrical controls to allow equipment alternation. Spare filter fabric shall be provided except when metal coils are utilized.

a. Feed pump.

b. Vacuum pump.

c. Filtrate pump.

2. Wetted parts should be constructed of corrosion-resistant material. Drum and agitator assemblies shall be equipped with variable speed drives and provisions for altering the liquid level shall be made.

3. Vacuum pumps having a capacity of at least 1.5 cfm per square foot for metal-covered drums should be provided. Vacuum receivers are required with dry type vacuum pumps.

4. Each filter shall be fed by a separate feed pump to ensure a proper feed rate. Filtrate pumps must be of adequate capacity to pump the maximum amount of liquid to be removed from the sludge.

5. Careful consideration to filter washing and variable sludge pickup depth should be made.

B. Plate and frame presses. Actual performance data developed from similar operational characteristics should be utilized for design. The impact that anticipated sludge variability will have on the design variables for the press as well as chemical conditioning shall be addressed. Appropriate scale-up factors shall be utilized for full size designs if pilot scale testing is done in lieu of full-scale testing.

1. The following appurtenant equipment shall be considered for duplicate operation unless multiple units are provided:

a. Feed pump.

b. Air compressor.

c. Washwater booster pump.

2. The following spare appurtenances shall be provided where multiple units are not installed:

a. At least one extra plate for every ten required for startup, but a total of not less than two extra plates required.

b. One complete filter fabric set.

c. Closure drive system.

d. Feed pump (when duplicates are not provided).

e. Air compressor (when duplicates are not provided).

f. Washwater booster pump (when duplicates are not provided).

3. Filter feed pumps shall be capable of a combination of initial high flow, low pressure filling followed by sustained periods of operating at 100 to 225 psi. An integral pressure vessel to produce this initial high volume flow should be considered. Operating pressures less than 225 psi will be considered if actual performance data using similar sludges is provided.

4. Provisions for cake breaking to protect or enhance downline process shall be incorporated where necessary.

5. Crane or monorail services capable of removing the plates should be considered. In some installations, the capability to remove other press parts should also be considered.

6. Provision for a high pressure water or acid wash system to clean the filter shall be considered. Booster pumping should be addressed.

C. Belt presses. Actual performance data developed from similar operational characteristics should be utilized for design. The impact that anticipated sludge variability will have on the design variables for the press as well as chemical conditioning shall be addressed. A second belt filter press or an approved backup method of dewatering shall be required whenever a single belt press is operated 60 hours or more within any consecutive five day period or the average daily flow received at the treatment works equals or exceeds four mgd. Appropriate scale-up factors shall be utilized for full-size designs if pilot plant testing is performed in lieu of full-scale testing.

1. The following appurtenant equipment shall be considered for duplicate operation unless multiple units are provided:

a. Feed pump.

b. Washwater booster pump.

2. Requirements for spare appurtenances should include the following:

a. Complete set of belts.

b. One set of bearings for each type of press bearing.

c. Tensioning and tracking sensors.

d. One set of wash nozzles.

e. Doctor blade.

f. Conditioning or flocculation drive equipment if duplicate units are not provided.

3. A polymer selection methodology, accounting for sludge variability and anticipated sludge loading to the press shall be provided.

4. Sludge feed shall be as constant as possible to eliminate difficulties in polymer addition and press operation. The range in feed variability shall be identified and equalization shall be provided as necessary. A method for uniform sludge dispersion on the belt shall be provided. Grinders for the sludge feed to the flocculation system shall be considered. Thickening of the feed sludge should be an integral part of the design of the filter press. Separate thickening or dual purpose thickening will be considered on a case-by-case basis.

5. The filter press design shall consider the following:

a. Variable belt speed mechanism.

b. Belt tracking and belt tensioning equipment.

c. Belt replacement availability based on evaluation of the belt equipment selection especially if the weave, material, width, or thickness cannot be reasonably duplicated.

6. Rollers specified for the press design should provide:

a. Rubber coating or other protective finish.

b. Maximum frame and roller deflection and operating tension.

c. Roller bearings that are watertight and rated for a B-10 life of 100,000 hours.

7. The washwater system should provide for:

a. High pressure washwater for each belt with a specified operating pressure.

b. Booster pumps if necessary.

c. Spray wash systems designed to be cleaned without interference with the system operation.

d. Particular care in nozzle selections and optional nozzle cleaning systems when recycled wastewater is used for belt washing.

e. Replaceable spray nozzles.

f. Spray curtains.

D. Additional design features to be considered include:

a. Drip trays under the press and under the thickener to readily remove filtrate if gravity belt thickening is employed.

b. Adequate clearance to the side and floor for maintenance and removal of the dewatered sludge.

c. Location of all electrical panels or other materials that are subject to corrosion out of the area of the press.

d. Adjustable doctor blade clearance.

9 VAC 25-790-640. Centrifuges.

Successful application of centrifugation similar to sludge thickening applications for dewatering of municipal type sludges requires consideration of certain design factors. Proper scale-up data pertaining to the particular sludge to be dewatered and the necessary polymer and coagulant dosage to achieve the design solids content shall be provided. The abrasiveness of each sludge supply shall be considered in scroll selection. Adequate sludge storage shall be provided for proper operation.

1. Unless dual trains are provided, the following spare appurtenant equipment shall be provided, with necessary connecting piping and electrical controls to allow easy installation:

a. Drive motor.

b. Gear assembly.

c. Feed pump.

2. Each feed pump shall be variable speed. A pump for each centrifuge shall be provided within the feed system.

3. Each centrifuge shall be equipped with provisions for variation of scroll speed and pool depth.

4. A crane or monorail shall be provided for equipment removal or maintenance.

5. Provision for adequate and efficient wash down of the interior of the machine shall be an integral part of the design.

9 VAC 25-790-650. Sludge pumping.

Pump capacities shall be adequate but not excessive. Provisions for varying pump capacity are desirable.

1. Duplicate units shall be provided where failure of one unit would seriously hamper treatment works operation.

2. Positive displacement pumps or other types of pumps with demonstrated solids handling capability shall be provided for handling raw sludge.

3. The minimum positive head necessary for proper operation shall be provided at the suction side of centrifugal type pumps. A positive head of 24 inches or more may be desirable for all types of sludge pumps. Maximum suction lifts shall not exceed 10 feet for positive displacement pumps.

4. Adequate sludge sampling facilities shall be provided. Provision of quick closing sampling valves installed at the sludge pumps would be an adequate means of sampling. The size of valve and piping shall be at least 1-1/2 inches.

5. Sludge withdrawal piping for anaerobic digesters and gravity thickeners shall have a minimum diameter of six inches for gravity withdrawal and four inches for pump suction and discharge lines. Where withdrawal is by gravity, the available head on the discharge pipe shall be at least four feet and preferably more. Also, where gravity withdrawal is to be used as the primary withdrawal method, the piping for the primary sludge clarifier pump should be so arranged as to permit use of the pump for removal of digested sludge. Downstream gravity piping for transport of sludge shall be laid on uniform grade and alignment. Slope on gravity discharge piping should not be less than 3.0%. Provisions shall be made for draining and flushing discharge lines, and special consideration shall be given to the corrosion resistance and continuing stability of supporting systems for piping located inside the digestion tank.

9 VAC 25-790-660. Sludge management.

Sludge management activities not specifically provided for through approval of design plans and specifications shall be described in a sludge management plan submitted by the owner to the area engineer and the DEQ regional office for review and approval. The use or disposal of treated sewage sludge shall be addressed through either the sludge management plan required by the VPDES permit, or a permit issued through the Biosolids Use Regulations (12 VAC 5-585).

Article 6.
Biological Treatment.

9 VAC 25-790-670. Attached growth processes.

A. The contactor, or media filled reactor, utilized for attached growth biological processes shall be preceded by primary clarification equipped with scum and grease collecting devices. Other pretreatment facilities equivalent to primary clarification may be proposed for evaluation by the department. The media shall provide sufficient surface area to support the attached biological growth necessary to achieve the desired performance standard. Recirculation of treated wastewater back to the contactor influent should be provided to maintain design loadings.

B. Trickling filters. Biological contactors called trickling filters shall be designed so as to provide either the reduction in biochemical oxygen demand required by the issued certificate or permit, or the treatment necessary to properly condition the sewage for subsequent treatment. This section provides performance criteria to achieve final effluent limits to meet federal secondary equivalency requirements for trickling filters. Such biological contactors may be designed to achieve higher degrees of treatment or used in conjunction with other unit operations. Where the design intent is to achieve other than secondary equivalency levels, the proposed design parameters shall be thoroughly reviewed during the preliminary engineering conference.

1. The hydraulic loading used for design of standard rate trickling filters shall be between two and four million gallons per acre per day with an organic loading between 400 and 800 pounds of BOD_5 per acre foot per day.

2. The hydraulic loading used for design of high-rate filters shall be between 10 and 30 million gallons per acre per day with an organic loading between 1,200 and 3,300 pounds BOD_5 per acre foot per day.

3. Other design loadings that are based on pilot studies and related to design and performance parameters through rational design equations or models will be evaluated by the department.

4. The performance of biological contactors can be detrimentally affected by diurnal loading conditions. The volume of media as determined from either pilot plant studies or from acceptable design equations shall be based upon the design peak hourly organic loading rate rather than the average rate. An alternative for reducing the design peak flow would involve provision of adequate flow equalization prior to the contactor.

5. Consideration should be given to the use of two-stage biological contactors in series operation where single stage reactors may not accomplish the required removals. Expected treatment efficiencies shall be calculated and documented.

C. Features. All hydraulic factors involving proper distribution of sewage on the contactor media shall be carefully calculated. For reaction type distributors, a minimum head of 24 inches between the low water level in siphon chamber and the horizontal elevation of the center of distribution arms shall be required. Surge relief to prevent damage to distributor seals shall be provided where sewage is pumped directly to the distributors. A minimum clearance of six inches between the media surface and the bottom of distributor arms shall be provided.

1. The sewage may be distributed over the contact reactor media surface by rotary distributors or other suitable devices that will permit reasonably uniform distribution to the surface area. At design average flow, the deviation from a calculated uniformly distributed volume per square foot of the filter surface shall not exceed plus or minus 10% at any point.

2. Sewage may be applied to the contactor media by siphons, pumps or by gravity discharge from preceding treatment units when suitable flow characteristics have been developed. Application of sewage should be continuous. In the case of intermittent dosing, the dosing cycles shall normally vary between five to 15 minutes with distribution taking place approximately 50% of the time. The maximum rest should not exceed five minutes based on the design average flow. Consideration shall be given to a piping system that will permit recirculation.

3. Underdrains with semi-circular inverts or equivalent shall be provided and the underdrainage system shall cover the entire floor of the filter. Inlet openings into the underdrains shall have an unsubmerged gross combined area equal to at least 15% of surface area of the filter. The underdrains shall have a minimum slope of 1.0%. Effluent channels shall be designed to produce a minimum velocity of two feet per second at the average daily rate of application to the filter. Provision shall be made for flushing the underdrains. The use of a peripheral head channel with vertical vents is acceptable for flushing purposes. Inspection facilities shall be provided.

4. The underdrainage system, effluent channels and effluent pipe shall be designed to permit free passage of air. The size of drains, channels, and pipe shall be such that not more than 50% of their cross-sectional area will be submerged under the design hydraulic loading. Provision shall be made in the design of the effluent channels to allow the possibility of increased hydraulic loading. Consideration should be given to the use of forced ventilation, particularly for covered trickling filters and deep (10 feet or more) contactors filled with a manufactured media.

5. The design should provide for variable rates of recirculation for various purposes; for example, to prevent drying of a standard rate filter between dosing. Devices shall be provided to permit measurement of flow to the filter process, including recirculated flows. The design should include provisions to flood filter structures where applicable.

6. All distribution devices, underdrains, channels and pipes shall be installed so that they may be properly maintained, flushed or drained. Mercury seals shall not be permitted. Ease of seal replacement shall be considered in the design to ensure continuity of operation.

7. A freeboard of four feet or more should be provided for all deep bed contactors with manufactured media that also utilize fine spray distributors, so as to maximize the containment of windblown spray.

8. Protection such as covers or windbreaks shall be provided to maintain operation and treatment efficiencies when climatic conditions are expected to result in problems due to cold temperatures.

D. Reactor media. Contact reactor media may be crushed rock, stone or specially manufactured material. The media shall be durable, resistant to spalling or flaking and relatively insoluble in sewage. The top 18 inches of rock or stone media shall have a loss by the 20-cycle, sodium sulfate soundness test of not more than 10% (as prescribed by ASCE Manual of Engineering Practice, "Filtering Materials for Sewage Treatment Plants," Manual of Engineering Practice No. 13, ASCE, New York, New York), the balance to pass a 10-cycle test using the same criteria. Stone media shall be free from iron. Manufactured media shall be chemically and biologically inert. The media shall be structurally stable to allow for distributor maintenance or a suitable access walkway shall be provided.

1. Rock or stone filter media shall have a minimum depth of five feet above the underdrains. Manufactured contactor media should have a minimum depth of 10 feet to provide adequate contact time with the wastewater. Rock and stone filter media depth should not exceed 10 feet and manufactured filter media should not exceed 30 feet except where special construction is justified through performance data or pilot plant studies.

2. Rock, stone, and similar media shall not contain more than five percent by weight of pieces whose longest dimension is three times the least dimension. They shall be free from thin elongated and flat pieces, dust, clay, sand or fine material and shall conform to the following size and grading when mechanically graded over vibrating screens with square openings:

a. Passing 4-1/2 inch screen--100% by weight

b. Retained on three-inch screen--95-100% by weight

c. Passing two inch screen--0-2% by weight

d. Passing one inch screen--0-1% by weight

e. Maximum dimensions of stone--five inches

f. Minimum dimensions of stone--three inches

3. Applications of manufactured media such as wood, plastic, etc., will be evaluated on a case-by-case basis. The handling and placement of the media should be specified.

E. Roughing reactors. Roughing contact reactors are used to reduce the organic load applied to subsequent oxidation processes. They are particularly applicable preceding an activated sludge process or a second stage filter in a treatment works receiving high strength wastewater (excessive organic loadings). Roughing filter designs differ from other contactors principally on the basis of the deeper depths and media design utilized for given loadings in comparison to high rate trickling filters. Since it is used to reduce the downstream organic loading rather than to provide a stabilized effluent, it is designed to receive organic loadings exceeding those applied to conventional biological contactors.

F. Granular media filters. Intermittently dosed biological sand filters utilized to process septic tank effluent to meet secondary treatment standards should be limited to schools, day camps and other installations that have part-time usage. These reactors should also be limited to those installations generating a sewage flow of 20,000 gallons per day or less and provide lengthy rest periods for filter operation. Biological sand filters may serve year-round residential dwellings if the design capacity is restricted to 1,000 gallons per day or less.

1. Biological sand filters shall not be used to treat raw wastewater and shall be preceded by a minimum of pretreatment designed to produce a settled sewage with adequate grease management. The use of biological sand filters designed to enhance effluent from other sewage treatment reactors shall be evaluated on a case by case basis.

2. Sand filter media beds shall consist of level areas of sand beneath which there are graded layers of gravel surrounding the underdrains. Each filter bed shall have an impervious bottom. Sewage is discharged onto the beds through rotary distributors or pipes onto splash plates or, in the case of subsurface filters, through lines of drain tile laid with open joints. Open sand beds shall be surrounded by a concrete, brick or cinder block wall extending above the sand and at least one foot above ground level. For subsurface sand filters, the surrounding wall is not necessary except to prevent caving of the earth walls while the sand and gravel are being placed. The underdrainage system shall consist of open joint or perforated pipe tied together into a manifold and vented to the atmosphere. The minimum size for the underdrain shall be four inches in diameter. The underdrain pipes should be placed on a slope of not less than 1.0%.

3. Rock, gravel and sand media components shall be clean and free of organic matter, clay or loam soils and fine limestone material.

a. The media depth shall not be less than 30 inches. Sand media for intermittently dosed and recirculated effluent, shall have an effective size of 0.30 mm to 1.0 mm and 0.8 mm to 1.5 mm, respectively. The uniformity coefficient should not exceed 4.0. No more than 2.0% shall be finer than 0.177 mm (80 mesh sieve) and not more than 1.0% shall be finer than 0.149 mm. No more than 2.0% shall be larger than 4.76 mm (4 mesh sieve). Larger granular media up to 5 mm in effective size may be considered on a case by case basis.

b. The gravel base for sand media shall conform to the Virginia Department of Transportation's Road and Bridge Specifications (1974). The base gravel shall consist of No. 3 sized gravel with at least a three-inch depth above the sloped underdrains. The middle layer shall consist of at least three inches of No. 68 gravel, and the top layer shall consist of at least three inches of No. 8 gravel.

4. Dosing tanks with either siphons or pumps for sand filters shall have the capacities to effect the dosage volumes required. The siphons and the rotary distributor should be supplied by the same manufacturer. The influent line to the rotary distributor shall be equipped with a valved drain.

5. Sand filters designed for intermittent flooding should be divided into at least two beds for small filters and three beds for the larger filters. Distribution boxes must be provided for diverting the sewage onto the filter bed or beds desired, as it is often necessary to take one filter bed out of operation during scheduled rest periods. Providing such rest periods will prevent surface clogging that results in sewage ponding above filter media. When three filters are employed, only two beds are normally used at any one time, the other bed being held out of operation for rest periods or maintenance, if required.

6. In the design of intermittently flooded sand filters the area of the filter beds is normally based upon a rate of application of 2.3 gallons per square foot per day. Also, a sufficient amount of settled sewage should be discharged onto the sand bed surface to cover the sand to a depth of two inches.

7. A rotary distributor will accomplish uniform application of settled sewage over the sand filter surface. A uniform application will maintain the design treatment efficiency of the filter so that a relatively higher dosage rate may be utilized or, for equal sewage flows, the area of sand bed required may be less than other designs. The design of the area of the filter beds equipped with rotary distributors should be based on an application rate of 3.5 gallons per square foot per day. The amount of sewage applied to the sand filter at each discharge of the dosing siphon should be equal to a depth exceeding one-half inch over the entire sand bed area being dosed.

8. The rate of dosage onto a buried sand filter shall not exceed 1.15 gallons per square foot per day of settled sewage. Settled sewage shall be applied to the filter through lines of drain tile laid with open joints, with the tile placed in a 12-inch layer of No. 3 stone. The top of the filter may be finished with a 12-inch layer of stone. Where it is not feasible or desirable to finish the top of the subsurface filter with stone, a 3-inch layer of straw covered with a four to eight inch layer of top soil may be used. Open joint underdrain tiles shall be sloped one inch per 10 feet and shall be installed in the base gravel and connected to the effluent pipe. The ends of the distribution lines should be tied together into a manifold and should be vented to the atmosphere. All open joints shall be covered with collars of asphalt paper or other suitable material.

Distribution boxes must be provided for diverting sewage onto the filter beds through headers, with each header connecting to not more than four distribution lines, where multiple units are used. Each application must completely fill the tile lines in use.

9. Consideration should be given to providing recirculation for granular media filters to improve treatment performance. Recirculating sand filters should be designed using a hydraulic loading rate of 3-1/2 gallons per day per square feet, based on average daily flow, with an organic loading rate not to exceed 0.005 pounds of BOD_5 per day per square foot of surface area. A recirculation ratio greater than 3:1 shall be provided. The use of granular media filters for nutrient removal will be evaluated on a case by case basis based on evaluation of performance data. Granular media filters shall be timer dosed and adjustable from one to 10 minutes of dosing per 30 minutes on time.

9 VAC 25-790-680. Rotating biological contactors.

A. The rotating biological contractor (RBC) treatment process may be used to accomplish carbonaceous and nitrogenous oxygen demand reductions. Expected performance of RBC equipment shall be based upon experience at similar full scale treatment works or through documented pilot scale testing with the particular wastewater.

B. Design. A minimum of two independent RBC units shall be provided for treatment works greater than 100,000 GPD. Provisions for positive and measurable flow control to individual contactors shall be provided. Piping shall permit each reactor to be operated in the parallel or series flow mode. The design of the RBC shaft and media support structures shall assure protection from structural failure for the design life of the treatment works.

1. In determining design loading rates, the following parameters shall be considered: design flow rate and influent waste strength; percentage of BOD_5 to be removed; media arrangement, including number of stages and unit area in each stage; rotational velocity of the media; wastewater temperature; and percentage of influent BOD_5 that is soluble. The maximum first stage loading shall not exceed three pounds soluble BOD_5 per day per 1,000 square feet of media surface area.

2. The contactor basin should be designed to allow a submergence of 30% to 40% based on total media surface area.

a. The clearance between the tank floor and the bottom of the rotating media shall be four to nine inches to maintain sufficient bottom velocities and prevent solids deposition in the tank.

b. Suitable means shall be provided to dewater each basin.

3. Rotating biological contactors shall be covered to protect the biomass from cold temperatures and the media from direct sunlight.

4. Enclosures shall be constructed of corrosion resistant material. Adequate clearance shall be provided for normal maintenance and reasonable access to the rotating shafts and for observation of the biomass. Windows or simple louvered mechanisms shall be provided for adequate equipment ventilation. To minimize condensation the enclosure should be insulated or heated.

C. Features. Provisions shall be made to allow access to the shaft bearings for routine maintenance and removal. In addition, hydraulic load cells (i.e., bearing lift or electronic strain gauges) should be provided to allow a determination of total shaft weight, which in turn can be used to estimate the depth of attached growth or the biofilm thickness. The drives used for shaft rotation may be provided through either mechanical gear reducers or special media features that utilize aeration as a turning force. A stand-by drive assembly shall be provided to ensure continuous operability.

1. Rotational velocity directly affects the level of wastewater treatment by providing contact, aeration, and mixing between the biomass and wastewater. The optimum rotational velocity will vary with the specific installations and is generally in the range of one to two revolutions per minute (RPM).

2. RBC mechanical drive assemblies should have the capability to vary shaft rotational speed for dissolved oxygen and biofilm thickness control. Drive systems and motors shall be provided with protective coatings suitable for high humidity environments.

3. Supplemental aeration shall be provided for the first stage of all mechanically driven RBC units with first stage soluble organic ($SBOD_5$) loadings greater than two pounds/1000 square foot of media surface. The air flow shall be supplied by air headers and diffusers located beneath the rotating media at a rate of not less than 1.25 cfm/1000 square foot of media surface area. The total design air flow rate may be provided by a single blower; however, two blowers, each providing 50% of the total air flow rate, are recommended. The design shall provide the capability to vary the volume of air delivered to handle fluctuations in the treatment works loading.

4. The design of an air drive system shall provide the capability to vary the volume of air delivered to handle fluctuations in treatment works loading or to control shaft rotational speed and biofilm thickness.

a. Air delivered shall not be less than 2.5 cfm/1000 square foot of media surface area to meet treatment objectives. For operational flexibility and biofilm thickness control, blowers shall be provided in multiple units, so arranged and in such capacities to allow delivery of 150% of the treatment air requirement with the single largest blower unit out of service.

b. Provisions shall be made for independent air flow metering and control to each RBC shaft.

5. At least two stages of RBC media for each flow stream shall be provided for secondary treatment applications. Additional stages shall be provided for nitrification or enhanced BOD_5 removals.

6. Design consideration should be given to providing: (i) recirculation of secondary clarifier effluent; (ii) positively controlled alternate flow distribution, such as step feed; and (iii) combination air/mechanical drive systems.

9 VAC 25-790-690. Suspended growth (activated sludge) process.

A. A number of variations of suspended growth treatment systems can be designed, featuring combinations of reactors utilizing aeration to support suspended biomass, and secondary clarifiers to separate suspended solids from the secondary effluent, that are known as activated sludge processes. Design standards, operating data, and experience for some of these variations are not well established and may not be considered as conventional design.

B. Design. The possibility of nonconventional technology approval should be considered in selection of a process modification. The conventional process and its various modifications may be expected to consistently produce an effluent containing no more than 30 milligrams per liter of either Biochemical Oxygen Demand (BOD_5), or total suspended solids (TSS), within the boundaries of the design parameters described in this chapter and with effective operation.

1. Designs to meet effluent limits more stringent than conventional secondary levels will be considered on a case-by-case basis when additional provisions such as flow equalization, increased clarifier capacity, or other process enhancement are proposed.

2. When the design includes multiple suspended growth reactors or aeration basins, provisions for combining the influent and return sludge and proportionally distributing the combined flows to each reactor shall be included to the extent practical. When the design includes multiple clarifiers, provisions for combining the effluent flows from all aeration basins and proportionally distributing the basin effluent with a uniform biomass concentration (mixed liquor suspended solids (MLSS)) to each secondary clarifier shall be included to the extent practical.

3. Effective removal of grit, debris and excessive oil or grease and grinding or fine screening of solids shall be accomplished prior to the activated sludge process. Aerated grit chambers alone will not provide adequate solids reduction.

C. Nitrification. The following requirements apply to activated sludge treatment works designed to provide nitrification.

1. The extended aeration modification shall be provided for single-stage activated sludge systems with a design flow of 0.5 mgd or less. Other modifications may be utilized for activated sludge systems with design flows greater than 0.5 mgd or two stage activated sludge systems; however, the design shall ensure that an adequate nitrifying bacteria population can be maintained during the required time period (i.e., seasonal or year-round) without excessive reactor biomass (MLSS). This requires (i) a longer detention time; (ii) a longer mean cell residence time (MCRT) with a relatively high ratio of the amount of biomass in the process compared to the rate of loss or wastage of biomass; and (iii) a lower organic loading rate than that required for carbonaceous organic removal alone.

2. The design for processes other than the extended aeration modification shall be based on satisfactory process performance obtained at full scale or pilot scale facilities. Performance data and information from such facilities shall be included with the design data submittal and shall particularly address temperature and pH dependence of the nitrification process.

3. Flow equalization or other proven methods to eliminate the likelihood of loss of biomass or activated sludge washout shall be provided for sewage treatment works subject to infiltration/inflow rates which could be expected to result in periodic biomass or activated sludge nitrifier washout.

4. Feed equipment for the addition of chemicals to maintain a minimum alkalinity of 50 mg/L in the aeration basin contents (mixed liquor) shall be provided when necessary, based on the characteristics of the influent wastewater. Approximately 7.2 pounds of alkalinity will be destroyed per pound of ammonia nitrogen oxidized. The design of the feed equipment shall meet the requirements of this chapter.

D. Reactor requirements. Multiple aerated suspended growth reactors (aeration basins) capable of independent operation shall be provided for all treatment works rated at greater than 40,000 gallons per day, with this exception: single units may be allowed for Reliability Class II and Class III treatment works having a capacity up to 100,000 gpd when the appropriate reliability and continuous operability requirements are satisfied, and provided that all aeration equipment is removable for inspection, maintenance and replacement without dewatering the reactor or clarifiers.

1. The size of the aeration basin for any particular adaptation of the process shall be based on such factors as (i) the design flow; (ii) degree of treatment desired; (iii) sludge age, (MCRT); (iv) mixed liquor suspended solids concentration (MLSS); (v) BOD_5 loading; and (vi) food to microorganism ratio (F/M). Calculations shall be submitted to justify the basis of design of the aeration basin capacity and process efficiency.

2. Aeration basin detention times, recirculation ratios, and permissible loadings for the several adaptations of the process are shown in Table 5. Operational parameters (sludge age, F/M, and MLSS) for the various process modifications are also included in this table as a guide.

3. The dimensions of each independent aeration basin or any off-line reaeration basins shall be such as to maintain effective mixing and utilization of air. Liquid depths should not be less than 10 feet except in special design cases.

For very small basins (volume less than 40,000 gpd) or basins with special configuration, the shape of the basin or the installation of aeration equipment should provide for elimination of short-circuiting through the basin. Aeration basins should have a freeboard of at least 18 inches.

4. Inlets and outlets for each aeration basin shall be suitably equipped with valves, gates, stop plates, weirs or other devices to permit control of the flow and to maintain reasonably constant liquid level. The hydraulic properties of the system shall allow the anticipated maximum instantaneous hydraulic load or peak flow to be carried downstream with any single aeration basin out of service.

5. Channels and pipes carrying liquids with solids in suspension shall be designed to maintain self-cleaning velocities or the flow shall be mixed to keep such solids in suspension at all rates of flow within the design limits. The means for adequate flow measurement shall be provided in accordance with Table 6 of this section.

6. Foam control devices shall be provided for aeration basins. Suitable spray systems or other appropriate means will be acceptable. If potable water is used, approved backflow prevention shall be provided on the water lines. The spray lines shall have provisions for draining to prevent damage by freezing.

TABLE 5.
TYPICAL ACTIVATED SLUDGE DESIGN AND OPERATION PARAMETERS.

Process Detention Modification Time (Hr.)	Recirculation Flow Regime Ratio	MCRT (Days)	Food to micro-organism Ratio (F/M)	Reactor Loading #BOD_5 per 1,000 cu. ft.	(MLSS) Suspended Solids (mg/L)
Conventional 4-8	PF 0.25-1.0	5-15	0.1-0.5	20-40	1500-4000
Complete Mix 4-8	CM 0.25-1.0	5-15	0.2-0.5	20-80	1500-4000
Step Aeration 4-8	PF 0.25-1.0	5-15	0.2-0.5	20-40	1500-4000
Contact Stabilization 0.5-1.5(1 3.6(2)	PF 0.25-1.5	5-15	0.2-0.6	30-50(1)	1000-3000(1) 8000-80000(2)
Extended Aeration(3) 24	PF 0.25-1.5	20-30	0.05-0.2	10-15	1500-3000
High Purity Oxygen(4) Systems 1-5	CM 0.25-0.5	5-15	0.15-1.0	100-250	4000-8000

Notes:

F indicates the amount of available organic substance in the influent to the reactor. M indicates the amount of viable biomass in the reactor measured as the volatile portion of the total suspended solids level (MLSS) in the reactor. PF indicates a plug flow hydraulic characteristic in which the measured residence time is 80% or more of the theoretical detention time. CM indicates a completely mixed basin whose contents have essentially the same characteristics as the average levels within the basin effluent. See 9 VAC 25-790-460 E (Table 4) for estimated values of secondary effluent from activated sludge reactors followed by secondary clarifiers.

(1) Contact Unit

(2) Solids Stabilization Unit

(3) Includes Oxidation Ditch Systems

(4) Reactors in Series

TABLE 6.
MINIMUM FLOW MEASUREMENT REQUIREMENTS FOR ACTIVATED SLUDGE.

	Treatment Works Design Capacity, Q, MGD		
Flow Stream	Q 0.04	0.04 < Q 1.0	Q > 1.0
Influent Sewage to each aeration basin(1)	None	Indicating	Indicating & Totalizing(2)
Air to each aeration basin	None	Indicating	Indicating
Return Activated Sludge to each aeration basin(1)	Indicating	Indicating	Indicating & Totalizing(2)
Waste Activated Sludge	Indicating & Totalizing	Indicating & Totalizing	Indicating, Recording & Totalizing

Notes:

(1) Where it can be verified by calculations or pilot studies that proportional flow distribution to each aeration basin can be maintained, then flow measurement devices for the influent and return activated sludge to each basin may not be required. However, as a minimum, the total influent and return activated sludge flows shall be provided with flow measuring devices to measure each flow separately.

(2) Recording and totalizing may not be required where adequate flow control is provided and totalizing refers to the total flow not individual basin flow.

E. Aeration. Oxygen requirements generally depend on BOD_5 loading, degree of treatment and level of biomass or suspended solids concentration to be maintained in the aeration basin (MLSS). Aeration equipment shall be designed to meet the oxygen demands of the activated sludge process and provide adequate mixing to rapidly mix the influent with the reactor contents and maintain the reactor biomass (MLSS) in uniform and complete suspension.

1. When the applied wastewater contains a substantial portion of industrial wastes which have characteristics significantly different from domestic wastes, then experimentally derived data shall be submitted to support the proposed oxygen requirements for the process. Calculations shall be submitted to justify the oxygen requirements and the equipment capacity.

2. The oxygen requirements for domestic waste shall be a minimum of 1.2 pounds of oxygen per pound of applied BOD_5 for the extended aeration process and a minimum of 1.1 pounds of oxygen per pound of applied BOD_5 for other processes listed in Table 5 of this section. In addition, oxygen requirements for nitrification of ammonium nitrogen shall be a minimum of 4.6 pounds of oxygen per pound of applied ammonium nitrogen for the extended aeration process, and for other processes, unless the proposed operation procedures will preclude nitrification by employing a low sludge age (MCRT).

3. The oxygen shall be supplied at a rate that can maintain a minimum aeration basin dissolved oxygen concentration under critical environmental conditions (i.e., temperature, pressure) of: 2.0 mg/l at average design organic loading, or 1.0 mg/l at peak design organic loading, whichever is greater.

4. The peak organic loading rate shall be the maximum organic loading applied to the aeration basin during a six-hour period. When influent data is not available or for new treatment works, the peak organic loading rate shall be two times the design average daily organic loading rate.

5. Certified test data shall be obtained for regulatory evaluation prior to installation that demonstrates the standard clean water oxygen transfer capabilities of the proposed diffused aeration equipment for treatment works with a design flow greater than 100,000 gpd and for proposed mechanical aeration equipment for all treatment works. The test data shall be developed using similar reactor and aerator configuration, basin depth, aerator depth as applicable, and air or energy input rates as proposed in the design. The procedures for conducting the clean water oxygen transfer tests shall be in accordance with the latest ASCE Standard for Measurement of Oxygen Transfer in Clean Water (see Part IV (9 VAC 25-790-940 et seq.) of this chapter).

6. The field oxygen transfer rate shall be calculated from the standard clean water oxygen transfer rate using the following equation:

Equation 1:

OTR_f	=	(Alpha)(SOTR)(Theta$^{(T\ 20)}$)(Tau*Beta*Omega*C*20- C)/C*20
Where:		
OTR_f	=	Field oxygen transfer rate estimated for the system operating under process conditions at a D.O. concentration, C-mg/l, and temperature, T-°C.
Alpha	=	Oxygen transfer correction factor for wastewater = (average wastewater KLA)/(average clean water KLA)
SOTR	=	Standard Oxygen Transfer Rate for clean water at standard conditions.
Theta	=	Empirical temperature correction factor; usually taken as 1.024.
T	=	Temperature in mixed liquor at design operating conditions, °C
Tau	=	C*st/C*s20
C*st	=	Tabular dissolved oxygen surface saturation value for clean water at standard barometric pressure of 1.00 atm, 100% relative humidity, and critical design operating temperature, mg/L.
C*s20	=	Tabular dissolved oxygen surface saturation valve for clean water at standard barometric pressure of 1.00 atm, 100% relative humidity, and standard temperature of 20°C, mg/L.
Beta	=	Dissolved oxygen saturation correction factor for wastewater = (dissolved oxygen saturation value for wastewater at standard conditions)/(dissolved oxygen saturation value for clean water at standard conditions).
Omega	=	Pressure correction factor
	=	Pb/Ps
Pb	=	Critical design operating barometric pressure, atm.
Ps	=	Standard barometric pressure of 1.00 atm.
C*20	=	Dissolved oxygen saturation valve for a given aeration device at standard barometric pressure of 1.00 atm and standard temperature of 20°C.

7. A discussion of the Alpha and Beta factors is provided in Part IV (9 VAC 25-790-940 et seq.) of this chapter. Further description and discussion of terms are provided in the ASCE Standard and Annexes for the Measurement of Oxygen Transfer in Clean Water and other related publications.

8. When conventional diffused air equipment performance data is not submitted, then minimum air supply to meet the oxygen requirements in terms of cubic feet of air per minute per pound of applied BOD_5 to the aeration basin shall be

1,500 CF /lb. per day BOD_5 for the conventional, complete mix, step aeration, and contact stabilization processes and 2100 CF /lb. BOD_5 for the extended aeration process.

9. Air supply for mixing requirements shall be 20 to 30 cubic feet per minute of air per 1,000 cubic feet of aeration basin volume. Air supply volume requirements shall be increased for aerated channels, pumpwells, or other air-use demands.

10. The air supply blowers shall be provided in multiple units, so arranged and in such capacities as to meet the maximum air demand with the single largest unit out of service. The design shall also provide for varying the volume of air delivered in proportion to the load demand of the treatment works. Time clocks or variable speed drives are acceptable. In addition, positive displacement blowers shall be equipped with either multispeed pulleys with sufficient horsepower or other means to change the speed from the motor drive up to the highest speed and capacity. The specified capacity of blowers or air compressors, particularly centrifugal blowers, shall take into account that the air intake temperature may reach 40°C (104°F) or higher and the pressure may be less than normal. Air supply intake filters shall be provided in numbers, arrangement and capacities to furnish at all times an air supply sufficiently free from dust to prevent clogging of the diffuser system used.

11. The spacing of diffusers in basins or channels shall be in accordance with the oxygenation requirements through the length of the basin or channel and should be designed to facilitate adjustments of their spacing without major revision to airheader piping. The arrangement of diffusers should also permit their removal for inspection, maintenance and replacement without shutting off the air supply to other diffusers in the basin or otherwise adversely affecting treatment performance.

12. Individual assembly units of diffusers shall be equipped with control valves, preferably with indicator markings for throttling or for complete shutoff. Diffusers in any single assembly shall have substantially uniform pressure loss.

13. The mechanism and drive unit for mechanical aerators shall be designed for the expected conditions in the aeration basin in terms of the proven performance of the equipment. The aeration equipment shall be designed to provide the total projected oxygen requirements. Minimum power input shall be 0.5 to 1.3 horsepower per 1,000 cubic feet of aeration basin volume for mixing. The design basis for determining mechanical mixing requirements shall be submitted. Due to the heat loss incurred by surface mixing, consideration shall be given to protecting treatment unit operations from ice and freezing effects.

14. Multiple mechanical aeration unit installations shall be so designed as to meet the maximum air demand with the largest aeration unit out of service. The design shall also provide for varying the amount of oxygen transferred in proportion to the organic loading. Time clocks, variable speed drives or variable aeration basin level controls are acceptable. A spare aeration mechanism shall be furnished for single unit installations.

F. Biomass control. The design of an activated sludge process shall include methods for returning settled biomass (secondary sludge) back to the inlet section to the aeration basin. The minimum secondary sludge return rate of withdrawal from the secondary clarifier or clarifiers is a function of the concentration of suspended solids in the aeration basin (mixed liquor) that are contained in the secondary clarifier influent. In addition, the secondary sludge volume index (as determined by Standard Methods for the Examination of Water and Wastewater) and the length of time that a design depth of sludge (blanket) is to be retained in the settling basin should be considered when selecting a sludge return rate.

1. The rate of sludge return expressed as a ratio of the average design flow shall generally be variable between the limits set forth in Table 5. The rate of sludge return shall be varied by means of variable speed motors, drives, air assisted withdrawal, flow control methods, or timers for such operations.

2. If motor driven sludge return pumps are used, the maximum return sludge capacity shall be obtained with the largest pump out of service. If air lifts are used for returning sludge from each clarifier basin, no standby unit will be required, provided the design of the air lifts are such as to facilitate their rapid and easy cleaning and if other suitable standby measures are provided.

3. Suction and discharge piping shall be designed to maintain a velocity of not less than two feet per second when sludge return facilities are operating at normal return sludge rates. Suitable devices for observing, sampling and controlling secondary sludge return flow from each secondary clarifier shall be provided.

4. The design of activated sludge processes shall provide methods for controlling the rate at which secondary sludge (waste sludge) is transferred to further treatment. For those treatment works with a capacity of one mgd or higher, the daily capacity for waste sludge transferal to sludge handling and treatment facilities should equal or exceed 20% of the total aerated reactor volume. For treatment works with a design capacity of less than one mgd, such waste sludge facilities should provide a minimum return rate of 10 gallons per minute. Means for observing, sampling and controlling waste sludge flow shall be provided.

G. High purity oxygen. The following additional requirements apply to activated sludge systems which utilize high purity oxygen for aeration.

1. The design of activated sludge processes utilizing pure oxygen aeration shall provide for covered and compartmentalized reactors to provide a series of stages for biological growth. Sampling ports shall be provided for each compartment of the biological reactors. An enclosed air-oxygen exhaust system shall be provided to collect and vent the reactor off-gases.

2. Mixing equipment shall be sufficient to maintain solids in suspension. Normally, the power input should be 0.5 to 1.3 horsepower per 10 cubic feet of aerator volume. The design basis for determining mixing requirements shall be submitted. Provisions shall be included for rapid removal or cleaning of the mixers.

3. The high purity oxygen storage and generation facilities and piping shall be remotely located from areas where flammable or explosive substances may be present. Warning signs shall be posted in the area of the oxygen storage and generation facilities. The covered aeration basins should be equipped with explosive atmosphere monitors and alarms in accordance with applicable state and federal regulations. An influent hydrocarbon monitor shall be included at the headworks to initiate operation of purge air blowers to vent reactor oxygen when explosive mixtures could occur.

4. At least two sources of oxygen shall be provided. On-site storage of oxygen for emergencies and peak demands is required. Storage of oxygen shall be determined by engineering analysis of the availability and delivery of oxygen to the treatment works site.

H. Biomass support systems. Modifications to the activated sludge process in which attached growth supports are located within the aeration basins will be considered on a case-by-case basis evaluation of performance data and approved through the provisions of this chapter.

9 VAC 25-790-700. Oxidation ditches.

A. An oxidation ditch process typically employs an extended aeration type of activated sludge process with a single channel or multiple interconnected concentric channels used as an aeration basin with a detention volume of 18 hours or more at the design flow rate. However, they may utilize some batch type operational principles.

B. Design. The geometry of the channels can vary; however, the oval is the most common configuration. Design requirements involving the use of duplicate oxidation ditches within the flow range of 40,000 gpd to 200,000 gpd shall be determined by the reliability class of the treatment works (Class I, II or III), the nutrient removal requirements, and the use of conventional dual final clarifiers. For design flows up to 100,000 gpd, a single oxidation ditch should be sufficient for secondary treatment of discharges to Class I reliability waters, if provided with external duplex clarifiers. In Class II and Class III waters, a single oxidation ditch may be acceptable for secondary treatment of flows up to 200,000 gpd. However, for treatment works permitted with effluent limits less than secondary or nutrient removal requirements, duplicate reactors and clarifiers shall be provided. In other cases, the treatment works size and location may allow for an exception for specific designs.

1. The multiple concentric channel basin can have any number of interconnected channels. This channel design scheme provides some process flexibility, since with minor modifications it can be changed to other activated sludge process modes. Typically, the outer channel (if multiple channels are present) receives unsettled raw sewage with a loading of 15 pounds per 1,000 cubic feet of volume or less. Shallow channels are usually four to six feet deep with 45° sloping walls. Deep channels have vertical side walls and are normally 10 to 12 feet deep.

2. The channels are characteristically lined to prevent erosion and leakage. Ditch lining should be constructed of reinforced concrete, asphalt or plastic liners. Shallow channels with sloped sidewalls are often constructed of concrete poured against earth backing and reinforced with welded wire mesh. Deep vertical wall channels require reinforced concrete walls.

3. Oxidation ditches may also be operated in alternating modes through on/off operation of aeration/mixing devices with intermittent changes in flow rates or direction. Influent wastewater can be diverted through one or more multiple reactors in which different operational phases (anoxic, aerobic, etc.) may occur. Effluent clarification may be accomplished within the reactor or within a separate clarifier. Automatically controlled weirs regulate flow direction and alternating operation of aeration/mixing equipment controls the operating mode. As with either standard continuous flow, or batch-type processes, the design duration of each operating phase is critical to performance reliability.

C. Aeration. Since oxidation ditches are considered a variation of the extended aeration modification of the activated sludge process, the requirements set forth in this chapter are applicable except as follows:

1. The mixing system shall be capable of maintaining a minimum velocity throughout the oxidation ditch cross-section of 1.0 fps at maximum design depth and solids concentration. For designs utilizing in-channel suspended solids removal the mixing system shall provide for all necessary variations in flow velocity to achieve adequate separation of suspended solids. Calculations and certified performance data for the mixing system shall be submitted to substantiate the adequacy of the proposed design.

2. Designs based on anoxic operation shall provide mixing and aeration system capacity for aerobic operation with adequate turndown capability to operate in the anoxic mode. Flexibility to allow for operation in the anoxic mode should be considered for all designs.

3. Designs should provide for variation in the oxygen supply independent of the mixing function.

4. The outlet from the oxidation ditch shall be separated from the inlet in such a manner as to prevent discharging of partially treated effluent.

5. Intra-channel clarifiers may be utilized if conventional settling rates are maintained and sludge handling, treatment and management provisions are satisfactorily addressed.

9 VAC 25-790-710. Sequencing batch reactors (SBR).

A. Usage. In accordance with the requirements of this chapter and standards contained in this chapter, batch operation modifications of the activated sludge process will be considered as conventional secondary treatment processes. Adequate performance data and information from a full scale treatment works of similar design, including the levels of influent wastewater characteristics that produce hydraulic and organic loading rates within 25% of values used in the proposed design, shall be provided if an SBR design is to accomplish an effluent quality more advanced than a secondary level.

B. Design. The design shall meet the applicable loading requirements. The operating cycle normally consists of FILL, REACT, SETTLE, DRAW, and IDLE sequences with alternating sequences of mixing and aeration on and off.

1. A minimum of two basins shall be provided for design flows in excess of 0.1 mgd. The minimum total basin volume shall be equal to the design daily influent flow volume and either upstream in-line or off-line storage is necessary to minimize influent flow during settling and decanting. Effective scum collection and removal equipment shall be provided.

2. The design basis for meeting oxygen requirements shall consider the variation in liquid level depth and the aeration sequence time.

3. The basin depth shall be sufficient to provide optimum separation of the settled biomass and the point of effluent withdrawal.

4. Adequate mixing shall be provided to resuspend settled solids at the start of the FILL sequence and maintain solids in suspension over the design liquid volume range.

5. A high liquid level overflow shall be provided between basins. The overflow shall be located as far as possible from the outlet device and in no case be closer than 10 feet from the outlet device.

6. Inlets to each basin shall be located as far as possible from the outlet and in no case be closer than 10 feet from the outlet.

7. Scum baffles or other suitable arrangements shall be provided to prevent scum from being withdrawn with the effluent.

8. Outlet facilities shall be designed to prevent resuspension of the settled solids in the basins. An adjustable flow rate control device shall be provided on each basin outlet.

9. Waste sludge control facilities shall have a rate per day equal to 50% of the total basin volume.

10. The FILL and DRAW sequences for an individual basin shall not overlap.

C. Features. Automatic control valves and switches shall be provided for controlling the operating sequences of each basin. Automatic control valves shall be capable of manual operation. Control sequences shall be adjustable to allow flexibility in operating time periods for each sequence. The control system shall provide automatic operation of the inlet valve and outlet valve to each basin, the air supply valve to each basin and the blowers or mechanical aerators.

1. The control system shall provide for automatic operation of downstream units or equipment as necessary. The control system should also provide automatic control of the waste sludge removal system. A spare automatic control unit shall be provided.

2. A monitoring system shall be provided that will indicate control system status and actual valve position of each automatically operated valve. Also, the control system status and the actual operational status of both the air supply system (blowers or mechanical aerators) and sludge removal system shall be monitored, when equipped for automatic operation. The monitoring system shall include an alarm to indicate a malfunction of the control system.

3. Dual hydraulic pumps and air compressors shall be provided when such facilities are utilized in conjunction with valve operators. Electrically operated valves shall be designed so as to fail only in the open position.

4. A high liquid level alarm for each basin shall be provided to signal an alarm condition prior to reaching the overflow pipe or port.

5. Influent flow and effluent flow measurement for the treatment facility shall be provided. The extent of the flow measurement equipment shall be in accordance with this chapter.

6. Disinfection and other downstream treatment units shall be sized based on the maximum design DRAW sequence flow rate.

9 VAC 25-790-720. Sewage stabilization ponds and aerated lagoons.

A. General design. Basins with surface areas many times larger than conventional biological reactors, that utilize relatively low (less than 500 mg/l) levels of biomass, are typically referred to as stabilization ponds (if unaerated) but are referred to as facultative lagoons if aerated. This section provides criteria for achieving final effluent levels of 45 mg/l BOD_5 and 45 mg/l, or higher suspended solids, as permitted limits applicable to the geographic allowance for sections of Virginia. This level of treatment has been established in accordance with the federal requirements for secondary treatment equivalency as achievable through the use of stabilization ponds and facultative lagoons. The design information contained herein pertaining to features other than biological treatment performance criteria shall apply to the construction of earthen basins used in the treatment of sewage.

Stabilization ponds or facultative lagoons may be designed to achieve a higher degree of treatment or used as a biological treatment phase in conjunction with other unit processes. Proposed design parameters to achieve other than 45 mg/l BOD_5 effluent limits shall be thoroughly reviewed with the area engineer during the preliminary engineering conference. Necessary features for protecting public health and welfare and preventing potential violations of water quality standards shall be addressed in the design report.

1. The engineering design report shall contain pertinent information on location, geology, soil conditions, area for expansion, and any other factors that may affect the feasibility and acceptability of waste stabilization ponds or aerated lagoons used for sewage treatment. Specifically, the report shall contain the following supplementary field survey data.

   a. The location and direction of all residences, commercial development, recreation areas and potable water supplies within one-half mile of the proposed pond or lagoon site. If practicable, ponds and lagoons should be located so that local prevailing winds will be in the direction of uninhabited areas.

   b. Borings or other necessary geophysical analyses required to determine surface and subsurface characteristics of the immediate area and their effect on the construction and operation of ponds or lagoons located on the site.

   c. Data demonstrating anticipated permeability at the elevation of the proposed pond or lagoon bottom.

   d. A description, including maps showing elevations and contours, of the site and adjacent areas suitable for expansion.

   e. A closure plan shall be submitted to the department prior to issuance of an operating permit.

2. The proximity of ponds or lagoons to potable water supplies and other water resources subject to potential contamination and location in areas of porous soils and fissured rock formations within the depth directly affected by the ponds or lagoons shall be reported to avoid area contamination. Monitoring and more stringent construction requirements may be required after consideration of such factors as distance from water sources, water uses, installation size, liner design, and wastewater characteristics. Adequate provisions shall be made to divert storm water around the ponds or lagoons and otherwise protect pond embankments.

3. Access control for the immediate area surrounding the ponds or lagoons shall be addressed by sufficient means, such as a woven wire fence at least six feet high. Vehicle access control shall be provided. Any access gate(s) shall be provided with locks.

   a. Appropriate signs shall be provided along the secured perimeter or fence around the ponds or lagoons to designate the nature of the facility and advise against trespassing. The size of the sign and lettering used shall be such that it can be easily read by a person with normal vision at a distance of 50 feet.

   b. Access for maintenance equipment, transporting chlorine cylinders and inspection shall be provided by an all-weather entrance road.

B. Loading design. For stabilization pond design with relatively uniform organic and hydraulic loading, the maximum loading shall be 30 pounds of BOD_5 per day per total surface acreage, measured at the four-foot water depth level. For stabilization ponds that are not intended to meet federal secondary treatment equivalency limitations but will be used for pretreatment, higher loading rates may be acceptable.

1. In no case shall the detention time be less than 45 days, based on a four-foot operation level. For purposes of design, evaporation is to be considered equal to rainfall. At a minimum, a pond system shall consist of two physically separated ponds providing three separate treatment cells. For treatment works receiving an average design flow of less than 0.04 mgd, a minimum of one pond with two treatment cells may be acceptable. Organic loading to the first upstream or primary cells receiving sewage influent shall be a maximum of twice the total design loading for the system.

2. The shape of all cells shall be designed to provide even distribution of flow throughout the system. Round or square ponds are acceptable; however, rectangular ponds with high length to width ratios (up to 10:1) are considered most desirable. If round or square ponds are used, appropriate aeration arrangements and baffling shall be provided in order to minimize short-circuiting. Earth dikes shall be rounded at corners to minimize accumulations of floating materials.

3. Multiple sections of pond volume or cells designed so as to be capable of receiving design loadings under both series and parallel operation are required for all except small treatment works (one-half acre of pond surface or less). The minimum freeboard shall be two feet above the maximum operation depth, except for treatment works receiving less than 40,000 gpd. Operation depth requirements include:

a. The minimum operation depth shall be two feet, excluding any sludge storage section.

b. The maximum operating depth shall be five feet, excluding any sludge storage section.

4. For Class I reliability, the treatment works should provide for operation under winter conditions. The design should include considerations for, but not limited to, winter storage and supplemental aeration, to prevent effluent deterioration during cold weather conditions.

5. Installations provided for intermittent operation at a higher than normal loading for a relatively short portion of the year will be individually considered, taking into account the ability of the volume of the pond system to absorb shock loads.

6. The pond design shall include provisions for sludge storage. The volume of sludge storage should be based on a 20-year design life. The sludge storage section should be located in the upstream portion of the primary cells of the pond system.

7. Piping should be provided around the first cell in order to allow for parallel operation of the first two upstream cells in a pond system.

C. Features. Embankments and dikes shall be constructed of relatively impervious materials and compacted sufficiently to form a stable structure. Vegetation should be removed from the area upon which the embankment is to be placed. Embankment material shall be free of vegetative material and large rocks (more than six inches in length). Topsoil relatively free of debris may be used as outer slope cover material. Construction details including methods of construction, compaction details, inspection and construction certification shall be included in the design specifications. Soils used in constructing the side slopes shall either be compacted within 3.0% of the optimum moisture content to at least 90% Standard Proctor Density, or compacted in accordance with the proper site specific geotechnical recommendations.

1. The minimum embankment top width should be eight feet to permit access of maintenance vehicles. Lesser top widths will be considered for lagoons designed to serve 200 persons or 0.040 mgd or less. The top width must be designed to allow adequate maintenance.

2. Outer slopes should not be less than three-horizontal-to-one-vertical and the inner slope should not be less than three-horizontal-to-one-vertical nor greater than four-horizontal-to-one-vertical.

3. Exposed embankments and excavated areas shall be protected against erosion by suitable seeding, sodding or other methods. Additional protection for embankments, such as riprap, may be necessary to protect against wave action and flood currents. A method shall be specified that will prevent vegetation growth one foot above and below the operating water levels.

4. The pond shall be as level as possible at all points. Finished elevations shall not be more than three inches from the average elevation on the bottom. The bottom shall be cleared of vegetation and debris. Organic material thus removed shall not be used in the dike core construction.

D. Liners. A liner shall be provided for all ponds in order to minimize seepage. Material shall be of acceptable standard to assure uniform placement and quality. Standard ASTM procedures or acceptable similar methods shall be used for all tests. Natural soil and enhanced soil (bentonite, cement, etc.) material used as liners should be capable of achieving a maximum coefficient of permeability of one tenth of one millionth of one centimeter each second ($1X10^{-7}$cm/sec) or approximately three centimeters per year or less. Following the specified level of compaction, liner material used for the pond's side and bottom shall have a coefficient of permeability of one millionth ($1X10^{-6}$) cm/sec or less. Bentonite, asphalt, and other sealant additive materials should be considered to enhance the impermeability of natural soil liners.

1. Synthetic liner material shall be selected considering the application and manufacturer's use recommendations. Minimum requirements for generally used materials are:

a. Plastic film (nonreinforced, covered)--thickness equal or greater than 0.020 inches.

b. Plastic film (nonreinforced, noncovered)--thickness equal or greater than 0.050 inch.

c. Asphalt panels (covered)--thickness equal to or greater than 0.25 inch.

d. Asphalt panels (noncovered)--thickness equal to or greater than 0.50 inch.

2. Construction should be planned and implemented to assure liner integrity throughout the coverage area for the design life of the liner. The design specifications shall include details of construction, inspection, and certification. Services of qualified soil scientists, manufacturer material certification and inspection, and other qualified means of assuring proper material installation should be used. The liner substrate should be free of organic material, graded, rolled and be level and smooth in nature. The preparation of a stable and adequately smooth substrate is important for liner installation.

3. Natural soil or enhanced soil liners shall be compacted at or up to 4.0% above optimum moisture content to at least 95% Standard Proctor Density (or 90% Modified Proctor Density) throughout the bottom and side coverage area. Soil liners shall not contain rock fragments greater than two inches in the longest dimension and shall have a compacted thickness of at least 12 inches. Soil layers shall be applied in multiple compacted lifts of six inches or less.

4. Soil enhancers (bentonite, cement, hot asphalt) used to improve soil impermeability can be used to reduce the required liner thickness. Although thickness may be reduced with improved impermeability, a minimum thickness of two inches shall be provided. The enhanced soil liner soil matrix should be screened and free of stones greater than 3/4-inches in the longest dimension. Reduced thickness enhanced soil liners should be covered with a six-inch compacted protective soil layer. All layers should be applied in lifts of six inches or less. Presence of smaller gravel will assist in erosion protection.

5. Synthetic liners shall be constructed in accordance with the manufacturer's applicable instructions for liner usage. Generally, these liners should be covered by a protective layer of soil to prevent surface damage and deterioration. The liner shall be top anchored with a minimum berm set back and anchor depth of 18 inches. Unless the manufacturer specifies otherwise, all seams should be perpendicular to the slope with the overlap in the down slope direction. The pond should be subsurface drained or the liner vented to protect against damage due to gas accumulation under the liner. Special care and design will be required to assure a tight seal around inlet and outlet structures. Pads will be required in areas of aerator action and other sources of high velocity flow.

a. If mechanical equipment may result in damage to liner, then a protective layer of soil or other material shall be provided.

b. The pond bottom liner shall be located at least two feet above the seasonal high water table.

E. Hydraulics. The influent line to the pond system shall conform to acceptable material requirements of this chapter. A manhole shall be installed at the terminus of the influent sewer line, preceding the pond system, and shall be located as close to the dike as topography permits. Its invert shall be at least six inches above the maximum operating level of the initial upstream pond to provide sufficient hydraulic head without surcharging the manhole. The influent line to the initial upstream pond shall slope uniformly to the inner toe of the sloping embankment. A bend may be used where the influent line changes direction at the inner toe of the dike embankment and pond bottom.

The sewer upstream from the manhole should not be surcharged unless the means to routinely flush the influent pipeline is provided. If sewage is discharged to the pond system through a force main or mains, an antisiphoning device shall be provided on the force main.

1. Influent and effluent piping shall be located as far apart as possible along the flow path to minimize short-circuiting within the pond.

a. The influent line to each pond should be located approximately at the center of the influent area provided to uniformly distribute influent flow. Influent lines or interconnecting piping to downstream or secondary cells of multiple cells in the pond system, that are operated in series, may consist of pipes through the separating dikes.

b. Influent mixing or dispersion shall be provided for ponds having two acres or more of water surface area. All gravity lines shall discharge horizontally above an erosion resistant surface. Force mains shall discharge vertically upward and shall be submerged at least two feet when operating at the three feet depth. Velocity in the force main at normal pumping rate must be sufficient to prevent deposit of grit in the force main.

c. A concrete-lined pad with a minimum size of four feet square or a surface with equivalent resistance should be provided to prevent erosion at the influent point of discharge to the pond.

2. The outlet structure shall be placed on the horizontal pond floor adjacent to the inner toe of dike embankment. A permanent type walkway from top of dike to top of outlet structure for access shall be provided. The outlet structure shall consist of a well or box equipped with multiple-valved pond draw-off lines. An adjustable draw-off device is also acceptable. The outlet structure shall be designed such that the liquid level of the pond can be varied from a three-foot depth to a five-foot depth in increments of one-half foot or less. Withdrawal points shall be spaced so that effluent can be withdrawn from depths of 0.75 feet to 2.0 feet below pond water surface, irrespective of the pond depth. The lowest draw-off lines shall be 12 inches off the bottom to control eroding velocities and avoid pick-up of bottom deposits. The overflow from the pond shall be taken near but below the water surface. The structure shall also have provisions for draining the pond. A locking device shall be provided to prevent unauthorized access to level control facilities. An unvalved overflow placed six inches above the maximum water level shall be provided.

3. Interconnecting piping for multiple pond installations operated in series should be valved or provided with other arrangements to regulate flow between structures and permit flexible depth control. Interconnecting piping and outlets shall be of materials meeting the requirements of this chapter.

9 VAC 25-790-730. Aerated lagoons.

A. Low intensity aerated basins containing relatively low levels (less than 500 mg/l) of biomass are also known as aerated lagoons. The designed construction details of aerated lagoons are often similar to stabilization ponds. However, the aerated lagoon liquid depth shall be sufficient to provide for uniform distribution of dissolved oxygen in the design range of six feet to 15 feet.

B. Design. Not less than two physically separated basins providing a minimum of three treatment cells shall be used to provide the detention time and basin volume required by the lagoon system design. For treatment works less than 0.04 mgd, one basin with two treatment cells may be acceptable. The basins shall be designed to receive established loadings for both parallel and series operation. The air diffusion equipment shall be capable of maintaining sufficient mixing and oxygen concentration in the aerated volume under maximum seasonal demand conditions. Consideration should be given to fixed or floating-type in-pond baffle walls with carefully placed openings, to minimize short circuiting effects and to maximize flow path length. Deep ponds with depths exceeding 10 feet shall be provided with baffling to ensure adequate flow distribution and proper detention.

1. Detention time is dependent on many variables including type of waste, temperature, effective volume and nutrient balance. For a typical sewage influent strength of 300 mg/l or less of BOD_5 or TSS, the lagoon system design shall require total detention times in the range of 20 days. In addition to adequate volume to achieve the desired detention time, the design for primary lagoons shall include a minimum of 10% additional volume for sludge storage.

2. The initial upstream, primary cell receiving influent flow shall contain a minimum of one third of the total system volume. For small treatment works (design flow of 0.04 mgd or less) the primary cell shall contain at least one half of the total design volume.

3. Design requirements, as with detention time, may be dependent on many variables. Generally, mixing energy to maintain adequate solids suspension will be the limiting factor. All aerated lagoon systems shall be designed to maintain a normal dissolved oxygen concentration of two mg/l throughout the system. Minimum aeration requirements shall be based on established mass transfer models considering the treatment variables involved. Aeration equipment shall be capable of transferring two pounds of oxygen per pound of BOD_5 applied to the basin. Calculations shall be submitted to justify equipment and aeration patterns.

4. The influent to a lagoon shall discharge into a highly turbulent area, if applicable, to facilitate mixing effects. Baffles and pipe diffusers shall be considered for provision of uniform distribution of flow into basins with a surface area of 10 acres or more. All systems shall be designed with piping flexibilities to permit isolation of any cell without affecting the transfer and discharge capabilities of the total system. In addition, the ability to discharge the influent waste load to a minimum of two cells or all primary cells in the system shall be provided. Screening shall be provided on influent lines to prevent damage to mechanical surface aerators.

5. The outlet structure shall be located in a quiescent zone, at such a depth and at the most remote location possible with respect to the basin inlet, so as to minimize suspended solids carryover and maximize basin detention. The outlet structure shall provide for withdrawal at controlled rates for multiple depth levels, such that the liquid level in the basin can be drained and can be varied in an easily accessible manner. A minimum of three incremental withdrawal elevations should be provided, including the minimum and maximum operating depths.

6. Provisions shall be made to allow final solids settling prior to discharge. This provision should be made through the use of either a final settling basin or by providing an adequate quiescent zone toward the end of the final treatment cell. If a final settling basin is used, it shall provide a minimum of 1.5 hours settling time and conform to applicable requirements specified in this chapter.

7. It may be desirable to provide for concrete or soil cement stabilization of bottoms, walls and embankments. However, they will not be required initially unless experience dictates their necessity. Adequate concrete pads shall

be provided under mechanical surface aerators to prevent bottom scour. For surface aeration, earthen embankment walls one foot above and one foot below the normal water level must be riprapped or stabilized with other suitable material to prevent erosion by wave action.

C. Mechanical aeration. Not less than two aeration units shall be used to provide the horsepower required. Aerators shall be located such that their circles of influence touch. The circle of influence is that area in which return velocity is greater than 0.15 feet per second as indicated by certified data. Without supporting data the following may be used as a guide:

Nameplate Horsepower	Radius in feet
5	35
10-25	50
40-60	50-100
75	60-100
100	100

1. The horsepower shall be sufficient to provide the oxygen required for BOD_5 satisfaction and mixing. In no case shall the horsepower be less than 10 horsepower per million gallons of basin volume.

A sufficient number of aerators shall be provided so that a design level of dissolved oxygen within a particular cell shall be maintained with the largest capacity aerator in that cell out of service. Installation of the backup aerator should not be required, provided that it can be placed into service prior to a detrimental decrease in dissolved oxygen levels.

2. Floating surface aerators should be anchored in at least three and preferably four directions. Interconnection of floating aerators is discouraged. Flexible cables are preferred over rigid ones.

3. Surface aerators should be designed to prevent icing. Consideration should be given to the installation of splash plates for control of misting. For platform mounted aerators, the platform legs should be spaced at a sufficient distance from the aerator to minimize the effect of ice build-up caused by splashing.

a. Aerator design should provide for periodic and major maintenance and repairs and shall provide for removal of the aerators for replacement if necessary.

b. Provisions shall be made for independent operation of each aerator by on/off switches, time clocks, etc.

D. Diffused aeration. The design for compressed air volume requirements shall include the basin aeration requirements together with air used in other channels, pumps, or other air-use demands. The air diffusion equipment shall be capable of maintaining sufficient mixing and oxygen concentration in the aerated volume under maximum seasonal demand conditions. Provisions shall be made for removal of deposits for unclogging of air diffuser openings. Consideration should be given to minimizing the points of access necessary for cleaning.

1. The specified capacity of blowers or air compressors, (particularly centrifugal blowers), shall take into account that the air intake temperature may reach 40°C (104°F) or higher and the pressure may be less than normal. Air filters shall be provided in numbers, arrangement, and capacities to furnish at all times an air supply sufficiently free from dust to protect equipment and prevent clogging of the diffuser system used.

2. The blowers shall be provided in multiple units, so arranged and in such capacities as to meet the maximum air demand with the single largest unit out of service. The design shall also provide for varying the volume of air delivered in proportion to the design load for individual cells of the lagoon system.

3. Calculations shall be provided to verify that blower pressure is sufficient to dewater the diffuser lines at saturation conditions under normal operating depths.

4. Diffusers shall be arranged in each basin to provide tapered aeration with maximum intensity near the inlet. The spacing of diffusers shall be in accordance with the oxygenation requirements of the total process, i.e., the organic loading in each cell. Diffuser spacing should be designed to facilitate adjustments without major revision to air header piping. The arrangement of diffusers should also permit their removal for inspection, maintenance, and replacement without completely dewatering the basin and without shutting off the air supply to other diffusers in the basin.

5. Individual assembly units of diffusers shall be equipped with control valves, preferably with indicator markings for throttling or for complete shut-off. Provisions must be made for subsequent air flow or pressure measurements and necessary air flow adjustments. Diffusers in any single assembly shall have substantially uniform pressure loss.

Article 7.
Effluent Polishing and Disinfection Processes.

9 VAC 25-790-740. Disinfection.

A. Disinfection processes are designed to inactivate actual or potential pathogenic microorganisms present in treated sewage effluents. Disinfection of treated sewage effluents shall be provided to prevent the occurrence of public health hazards in either receiving streams, land treatment sites, or reuse applications from wastewater effluents. Disinfection shall be accomplished in a manner that meets standards for indicator microorganisms but does not result in a violation of toxicity standards.

B. Policy. The need for disinfection of a sewage treatment works effluent is primarily based on standards for either the receiving waters and the land application site or public exposure to reuse as determined by the following requirements:

1. Discharges located within 15 miles upstream or one tidal cycle downstream of a water supply intake shall be disinfected at all times.

2. When sewage discharges are permitted to or within five miles upstream of shellfish waters, they shall be disinfected at all times.

3. Discharges located in all other waters shall be disinfected at all times unless it can be demonstrated, through the use of a Site Specific Beneficial Use-Attainability Analysis of the recreational and other beneficial seasonal uses of the receiving stream, that disinfection is not needed throughout the year, or on a seasonal basis, to protect those uses.

4. Discharges for land treatment or reuse purposes shall be disinfected as necessary to protect the public health and welfare. The public shall not be directly exposed to treated effluent.

C. Toxicity reduction. The need for reducing the effect of toxicity from wastewater effluents is based on the characteristics of the discharge and receiving stream and is established at the time of the permit or certificate issuance. Where the need is established, dechlorination or alternate disinfection methods shall be provided.

9 VAC 25-790-750. Chlorination.

A. Disinfection can be accomplished through the controlled application of chlorine compounds to treated sewage to accomplish a sufficient dose, or contact exposure level, over a sufficient period of time, to achieve compliance with the indicator microorganism standard.

B. Chemical. Conventional types of chlorine compounds (chemical) include:

1. Chlorine gas is a greenish-yellow gas with a density greater than the density of air at room temperature and pressure. When compressed to pressures greater than its vapor pressure, chlorine gas condenses into a clear amber liquid.

2. Dry chlorine, liquid or gaseous, contains no more than 150 ppm of water (by weight). Unless otherwise indicated, the word "chlorine" wherever used in this section refers to dry chlorine.

3. A chlorine solution is a mixture of chlorine and water.

4. A hypochlorite solution is a mixture of either sodium or calcium hypochlorite and water.

5. A hypochlorite tablet is a solid formulation of a hypochlorite compound designed to dissolve in a liquid at a controlled rate.

C. Design. Chlorination feed equipment capacity shall be based on the degree of treatment, flow variations, and other uses in the treatment processes. For disinfection, the capacity shall be adequate to produce the residual required in the certificate or permit issued, in the effluent, after the required contact period. Conventional chlorination should be designed to provide a Total Residual Chlorine (TRC) level of up to 1.5 mg/l following a design contact period of 30 minutes or more. Chlorination should be considered for the control of odors and sludge bulking.

1. For normal domestic sewage the dosing capacities listed in Table 7 are recommended:

TABLE 7.
MINIMUM DESIGN CHLORINE DOSAGES.

EFFLUENT BOD/SS CONCENTRATION	DOSAGE (Based on Maximum Daily Flow)
30/78 mg/1	20 mg/1
45/45 mg/1	15 mg/1
30/30 mg/1	8 mg/1
20/20 mg/1	6 mg/1

10/10 mg/1	4 mg/1
<10/10 mg/1	<4 mg/1
Odor/Sludge Bulking Control	>20 mg/1

2. Standby chlorination capabilities shall be provided that will ensure adequate disinfection with any essential equipment of the unit operation out of service for maintenance or repairs. An adequate inventory of parts subject to wear and breakage shall be maintained at all times. An automatic changeover system shall be provided for either (i) treatment works with a design flow of 1.0 mgd or greater or (ii) discharges to critical waters, unless the treatment works are manned 24 hours per day. Where several cylinders are needed to feed sufficient chlorine, separate connections shall be provided for the duplicate gas supplies.

3. A sufficient supply of water shall be available for operating the chlorinators. Where a booster pump is required, duplicate pumping equipment shall be provided, except for discharges to critical waters, in which case duplicate pumps shall be installed. Where an onsite well is used for operating the chlorinators, an adequate back up shall be provided to ensure continuous disinfection. When connection is made from domestic water supplies, equipment for backflow prevention shall be installed. Pressure gauges shall be provided on chlorinator water supply lines.

4. Equipment for measuring the amount of chlorine used shall be provided. Where chlorine gas cylinders are used, scales shall be provided for weighing the cylinders. Scales should be manufactured with a material that is resistant to corrosion by chlorine. Adequate means for supporting the cylinders on the scales shall be provided. At large treatment works, multiple scales of the indicating and recording type are recommended. The recessing of scales is recommended to aid in changing of cylinders if hoists are not provided. Where manifolding of several cylinders will be required to feed sufficient chlorine, consideration shall be given to the installation of evaporators.

D. Dose control. The introduction of chlorine compounds (chemical) at a controlled feed rate is a critical area of disinfection system design.

1. Manual control is the simplest strategy for controlling the chemical feed rate. Generally the feed rate will be constant with minor adjustments made by the operator. This method is normally utilized at smaller treatment facilities.

2. Flow proportioning control in which the chemical feed rate is paced in proportion to the effluent flow rate by appropriate equipment is typically used at treatment works receiving more than 0.1 mgd influent flow.

3. Residual control may be used where the pacing of the chemical feed rate is based on residual analysis of a chemical compound or oxidation-reduction potential in the sample stream.

4. Compound loop control involves a system with interlocking controls that combines the regulation of chemical feed by flow proportioning with subsequent adjustment of the flow proportion dosage in reference to the chemical compound residual. This system is used at treatment works receiving more than 1.0 mgd of influent flow.

5. Solution-feed vacuum-type chlorinators are generally preferred for gas chlorination. Positive displacement type feeders are preferred for hypochlorite solution. Tablet chlorinators may be considered on a case-by-case basis for design flows up to 50,000 gpd.

6. The control system requirements for chlorine feed shall be in accordance with Table 8 as follows:

TABLE 8.
CHLORINE DOSAGE CONTROL SYSTEMS.

Design Flow MGD	Type of Control System Recommended
<0.04	Manual Control
0.04 to 5.0	Flow Proportioning (1)
1.0 to 5.0	Compound Loop (2)
5.0 or greater	Compound Loop

Notes:

(1) Manual, or residual control, may be allowed for flows up to five mgd if equalization of flow prior to disinfection is provided, or allowed for unequalized flows up to one mgd when the discharge is not to critical waters. Flow proportioning control may be allowed for discharges up to five mgd to other than critical waters.

(2) Required for discharges to critical waters and when dechlorination is necessary to meet effluent requirements for maximum chlorine residuals (TRC) of 0.5 mg/l or less.

E. Dose application. The applied chlorine compound shall be uniformly mixed with the influent to the contact basin. The flow shall be retained within the contact basin for the time period necessary to achieve the design dose.

1. Provisions for mixing shall be made to ensure uniform mixing of the chlorine solution or chemical with the wastewater flow near the point of application prior to and without interfering with the design contact period. This may be accomplished by either the use of turbulent flow regime or a mechanical mixer. A mean velocity gradient (G) value of 500 to 1,000 per second (Sec^{-1}) is recommended. The engineer shall provide calculations to justify adequate mixing.

2. A minimum contact period of 30 minutes at average daily flow or 20 minutes at maximum daily flow shall be provided within basins or channels immediately following the application of chlorine. A minimum contact period of 60 minutes at average daily flow or 30 minutes at the maximum daily flow shall be required for treatment works that are not continuously manned and that discharge to shellfish waters as defined in the state Water Quality Standards (9 VAC 25-260). The contact period shall be based on whichever criterion is more stringent.

3. A chlorine contact tank is a basin specifically designed to retain chlorinated effluent for the design contact periods following the application of chlorine. Continuous disinfection shall be provided. The design shall provide continuous chlorination while the chlorine contact tanks are dewatered for cleaning. Multiple basins will be required when mechanical sludge collection equipment is utilized in the contact tanks. For all treatment works with a design flow of 40,000 gpd or greater, multiple tanks shall be provided unless other provisions are made to prevent discharge of nondisinfected effluent. The contact tanks shall be designed to provide plug flow type hydraulics, with baffling provided to achieve a flow path length to flow path width ratio of at least 20 to 1 and a basin depth to basin width ratio of approximately 1.0.

F. Features. Disinfection piping systems shall be well supported, adequately sloped to allow drainage, and protected from mechanical damage. Suitable allowance shall be provided for pipe expansion due to changes in temperature. It is recommended that joints in chlorine piping be flanged or welded.

1. Piping materials shall be suitable for use with chlorine gas or solution, in conformance with the latest standards of the Chlorine Institute.

2. Where adequate superheat is not provided by an evaporator, condensation should be prevented by reducing the pressure with a pressure reducing valve.

3. Where odor control is accomplished by prechlorination, solution piping shall be arranged such that the necessary chlorine application can be accomplished.

4. Any building that houses chlorine equipment or containers shall be designed and constructed to protect all elements of the chlorine system from fire hazards in accordance with applicable codes and regulations. If flammable materials are stored or processed in the same building with chlorination equipment other than that utilizing hypochlorite solutions, a fire wall shall be erected to separate the two areas. If gas chlorination equipment and chlorine cylinders are to be in a building used for other purposes, a gas-tight partition shall separate this room from any other portion of the building. Doors to this room shall open only to the outside of the building and shall be equipped with panic hardware. Such rooms shall be at ground level and should permit easy access to all equipment. The storage area should be separated from the feed area. At least two means of exit should be provided from each separate room or building in which chlorine, other than hypochlorite, is stored, handled, or used. All exit doors shall open outward or roll-upward. A clear-glass, gas-tight window should be installed in an exterior door or interior wall of the chlorinator room to permit the chlorinator to be viewed without entering the room.

5. Chlorinator rooms shall be provided with a means of heating so that a temperature of at least 15°C (60°F) can be maintained. The room shall also be protected from excess heat. Forced, mechanical ventilation that will provide one complete air change per minute shall be installed in all chlorine feed rooms and rooms where chlorine cylinders are stored. The entrance to the air exhaust duct from the room shall be near the floor and the point of discharge shall be so located as not to contaminate the air inlet to any building or inhabited areas. The air inlet shall be so located as to provide cross ventilation with air at such a temperature that will not adversely affect the chlorination equipment. The vent hose shall run without traps from the chlorinator and shall discharge to the outside atmosphere above grade.

6. The controls for the fans and lights shall be such that they can automatically operate when the door is opened if a remote disconnect or override switch is provided in an identifiable, safe, remote location and they can also be manually operated from the outside without opening the door.

G. Safety. Respiratory protection procedures and equipment in compliance with VOSH and other applicable standards (National Institute for Occupational Safety and Health (NIOSH)/Mine Safety and Health Administration (MSHA)) should be available where chlorine gas is handled, and should be stored at a convenient location, but not inside any room where chlorine is used or stored. For treatment works designed for one mgd or greater, it is recommended that at least two complete sets be provided.

1. Instructions for using the equipment shall be posted. The use of compressed air or oxygen, with at least a 30-minute capacity, as compatible with such units used by fire departments (responsible for the treatment works) is recommended in accordance with applicable local, state, and federal standards.

2. A bottle of approximately 50% ammonium hydroxide solution shall be available for detecting chlorine leaks. Where 150-pound cylinders, ton containers, or tank cars are used, a proper leak repair kit (as the type approved by the Chlorine Institute) shall be provided.

3. Consideration should be given to the provision of chlorine gas containment scrubber system with caustic soda solution reaction tanks for absorbing the contents of leaking ton containers where such containers are in use.

4. For treatment works designed for a one mgd or greater average influent flow, automatic gas detection and related alarm equipment should be provided in accordance with VOSH and other applicable requirements.

H. Monitoring. Facilities shall be included for collecting a sample following the contact period to determine the effectiveness of the disinfection method.

1. Equipment shall be provided for measuring chlorine residual in accordance with EPA approved methods.

2. For discharges to critical waters, equipment or services, or both, shall be provided for monitoring the level of indicator microorganisms for pathogenic organisms, in accordance with EPA approved methods, in order to verify the disinfection efficiency.

3. Requests to establish a chlorine (TRC) reduction program, for maintaining a TRC below 1.0 mg/l in the chlorine contact effluent, shall be evaluated based on submission of at least one year of adequate monitoring results comparing TRC values and corresponding indicator microorganism results.

9 VAC 25-790-760. Bromochlorination.

A. Disinfection by bromochlorination is accomplished with bromine chloride (BrCl) in a manner similar to chlorine disinfection. Bromine chloride is an equilibrium mixture of bromine and chlorine in both the gas and liquid states. The chemical is highly soluble in water and hydrolyzes to hypobromous (HOBr) and hydrochloric (HCL) acids. Due to the rapid decay of bromine chloride in wastewater, generally there will not be any measurable bromine chloride residuals in the final sewage effluents. Pure bromine chloride is a heavy, fuming, dark, red liquid which is about 20% disassociated into molecular bromine and chlorine.

B. Design. This disinfection process can be considered for treated effluents with BOD_5 and suspended solids concentrations of 30 mg/l or less. Prior documentation should be furnished which shows that adequate disinfection of a specific sewage effluent can be obtained with this process.

C. Dose control. Bromochlorination feed equipment capacity shall be based on degree of treatment, flow variations, and other uses in the treatment processes. For disinfection, the capacity shall be adequate to produce the control point residual required in the permit or certificate issued. The dosing capacity of this process for normal domestic sewage should usually be 80% of that recommended in the chlorine dosage Table 7.

1. Bromochlorination equipment and spare parts are essentially the same as similar requirements for chlorination.

2. Gas feeder systems may be used for feed rates less than 500 pounds per day. Direct liquid bromine chloride feed systems should be used for feed rates greater than 500 pounds per day.

D. Features. Where adequate heat is not provided by the vaporizer to prevent condensation, the use of auxiliary heating and insulation shall be provided as necessary.

1. Materials for piping and appurtenances shall be suitable for handling gas, pure liquid or solutions of bromine chloride as appropriate.

2. The required housing shall be the same as for chlorination, as per VOSH requirements.

3. An evaporator shall be provided for all gas feed systems. The equipment should be designed to minimize the time out of service for maintenance. A backup system shall be provided to ensure adequate disinfection for all discharges when the vaporizer is out of service for maintenance. The vaporizer system should provide superheated gas to the inlet of the vacuum-operated bromine chloride feeder.

E. Safety. The requirement for safety shall be the same as for chlorination and should be in accordance with VOSH requirements. A physical barrier shall be provided for the separation of storage areas if bromine chloride and chlorine chemical supply containers and gas cylinders are located in the same room.

F. Monitoring. Facilities shall be included for collecting samples for bromine chloride residual determinations at the five minute contact time control point and for pathogenic bacterial indicator organism determinations following the total contact period. There should be no readily detectable bromine residual within the final effluent.

1. As bromochlorination equipment represents new technology and limited performance data is available for these systems, an initial period of increased sampling frequency and testing requirements for pathogenic bacterial indicators, such as fecal coliform, may be required. The required initial testing program should take place over a

period of one year or more under reasonable operating conditions with a minimum sampling frequency of at least once per week.

2. Disinfection of secondary or better quality effluent should consistently maintain a fecal coliform level below 200 per 100 milliliters of sample volume, or the allowable level contained in the certificate or permit issued, whichever is more restrictive.

3. Indicator organism test results should be correlated with other measurements at the time of sampling, including flow rate, effluent suspended solids, bromine dose rate, and residual measurements.

9 VAC 25-790-770. Ultraviolet light irradiation (UV).

A. Disinfection can be achieved through exposure of microorganisms to a sufficient level of UV at the germicidal wavelength for an adequate period of time.

B. Design parameters. The following parameters are important to UV disinfection design:

1. The absorbance coefficient is a measure of the UV absorbing characteristics of the irradiated fluid as measured by a single beam spectrophotometer at 253.7 nanometers, using both filtered and unfiltered fluid samples. The units of this parameter are absorption units per unit distance from the UV source.

2. The contact period is the period of time that a microorganism is exposed to a given intensity and is a function of the residence time distribution (RTD) of flow moving past an arrangement of UV lamps which can be determined from tracer tests.

3. The UV dose is a function of the product resulting from multiplying the average UV intensity, by the contact period (T) and is expressed as (microwatts)(seconds)/square centimeter (UW/SQ.CM/SEC).

4. The dose response is a measure of the inhibition of cell replication, and is indicated by the ratio of the monitored log counts of an indicator organism prior to and following exposure to a given UV dose.

5. The dispersion coefficient (E) is a measure of turbulent mixing (square centimeters per second) within the fluid passing through an arrangement of UV lamps. The value of E established by the RTD variance should be correlated with the contact time necessary to provide the required dose response.

6. The intensity is an expression of the rate (units of microwatts per square centimeter) at which energy is delivered from the source into the surrounding liquid. UV intensity will dissipate by dilution and will be absorbed by the medium as the distance from the source increases. The UV intensity provided for disinfection purposes should be approximated on the basis of the physical properties of the UV lamps, the physical arrangement of lamps within a flowing liquid stream, and the properties of the wastewater effluent (Kab).

7. Lamp assemblies are defined as the arrangement or grouping of UV lamps occupying the cross-section of a channel or reactor.

8. Photoreactivation is a process whereby certain organisms regain the ability to reproduce upon exposure to secondary light.

C. Design dose. This disinfection process shall only be considered as conventional when designed to treat effluent with BOD_5 and suspended solids concentrations of no more than 30 mg/l and that consistently maintains a filtered KAB(Base e) of no more than 0.4/centimeter. The minimum average design intensity and dosage provided by each lamp assembly shall be specified. Conventionally designed lamp assemblies shall not receive a maximum flow in excess of three mgd unless sufficient operating data is submitted to verify disinfection performance for similar wastewater flows in excess of three mgd.

1. Conventional UV process design shall provide a minimum average dose of 50,000 microwatt-seconds per square centimeter after the UV lamps have been in operation for 7,500 hours or more unless sufficient information is provided to demonstrate that the required level of disinfection can be obtained at a lower dose level.

2. UV designs based on dose-response models shall be verified by acceptable bioassay test results, and the expected influent level of indicator microorganisms shall be determined to verify the design.

3. Photoreactivation effects should be accounted for by the UV design.

D. Features. The current configurations acceptable for UV disinfection equipment include contact systems with submerged UV lamps enclosed in quartz tubes and noncontact systems with UV lamps situated adjacent to the flow surface or adjacent to teflon-lined tubular channels carrying treated effluent. Conventional UV disinfection system design shall include, as a minimum, two separate lamp assemblies with each assembly capable of providing the level of disinfection necessary to meet the disinfection standard at average daily flow. If no more than two lamp assemblies are provided for treatment works discharging to critical waters, then each assembly shall be capable of disinfecting the maximum daily flow. Upstream screens should be provided for unfiltered effluent to prevent breakage of quartz tubes by debris. In addition, these systems should be protected against "shock" hydraulic loads from pump station flows.

1. As quartz effectively passes the germicidal portion of light emitted by UV lamps, a quartz tube should be used to enclose UV lamps that are submerged in the treated effluent. The quartz tubes shall be watertight and not subject to breakage under normal usage. As teflon also passes the germicidal portion of light emitted by UV lamps, teflon lined channels may also be used to separate UV lamps from direct contact with treated effluent. Lamp alignment should provide for maximum contact periods and for reduced opportunity for blockage by debris around the submerged lamps. The downstream fluid head should maintain full flow within teflon lined channels. The strength needed to prevent channel deformation in relation to wall thickness should be established by the designer for these channels. The teflon tubes should normally be supported to prevent sagging during operation. Provisions should be made for air bleeding of this system by the operator when necessary.

2. Lamp spacing in channels or reactors should be sufficient to use the light in the solution rather than absorb it on adjacent lamps and walls. The lamp spacing should provide for the absorbance of the fluid disinfected. For good quality secondary effluent (absorbance (Base e) 0.3/cm or less) the spacing between lamps should be no more than eight cm with good mixing provided along intensity gradients. The arrangement and numbers of lamps included in each assembly shall be designed to facilitate proper maintenance. All electrical connections to submerged lamps shall be watertight and designed so as to remain dry during maintenance operations.

3. UV lamp specifications should include as minimum the following or demonstrated equivalent:

a. Availability (at least two manufacturers).

b. 90% or more emitted light output at 253.7 nanometers.

c. A minimum arc length that exceeds lamp length.

d. A rated output of 120 UW/SQ.CM. or more at 1.0 meter from the source.

e. A rated operating life in excess of 7500 hours during which time the UV output exceeds one-half of the rated output.

f. The lamps should not produce significant ozone or hydrogen peroxide.

g. Temperature control should provide for maintaining 105°F to 120°F surface temperature.

4. A single ballast should be utilized to provide power to no more than two UV lamps. Ballasts may be mounted side by side in a control box and shall be specified or labeled to indicate their corresponding UV lamps. A set of lights should indicate the on-off status of each lamp and should be visible without opening the control box. The ballasts generate a significant amount of heat, and forced-air ventilation or positive cooling of control boxes shall be provided. The set of ballasts serving each assembly of UV lamps shall be mounted in separate (physically separated) arrangements or control boxes. Control boxes shall be designed and installed in such a manner that replacement of individual ballasts will not result in discharge of undisinfected effluent.

5. The system of electrical connections shall be designed so as to minimize maintenance problems associated with breakage and moisture damage. The electrical system shall be designed so that routine maintenance can be achieved without loss of disinfection efficiency.

6. UV lamp assemblies shall be so located as to provide convenient access for lamp maintenance and removal. Provisions shall be made so that lamp assemblies may be observed and the channel surface physically inspected. Flow channels should be entirely accessible for cleaning to remove film deposits of material interfering with UV disinfection.

7. At least one UV intensity meter within each assembly of lamps shall be provided to indicate operating conditions. The intensity reading should be indicated on the control panel for each lamp assembly. For treatment works with a design average daily flow of one mgd or higher, flow metering shall be provided and appropriate spectrophotometric equipment shall be provided to measure the UV absorbance of the wastewater. An elapsed time meter shall be provided to indicate the total operating time of the UV lamps.

E. Dose control. For treatment works with a design average daily flow of one mgd or more, UV system design should include a control system to turn appropriate lamps on or off in order to conserve energy. The reliability of proposed automated control systems connected to flow sensors shall be demonstrated through submission of acceptable supporting information. Manual control should be based on diurnal flow variations.

1. A spare UV lamp (and quartz tube, if appropriate) shall be provided as a minimum at all UV installations. The number of additional spare lamps (and quartz tubes if appropriate) provided shall equal the nearest whole number equivalent to 10% of the number of lamps required to disinfect the maximum flow rate. Spare ballasts shall also be provided at all UV installations in numbers sufficient to operate the spare lamps.

2. UV equipment design shall provide for routine chemical cleaning with a proper acid/detergent cleanser. A chemical mix tank, circulation pump and upstream/downstream connections should be provided. A weak acid such as citric acid may be utilized for chemical cleaning of quartz tubes, but a stronger acid is recommended for more effective and more economical maintenance. Acid levels with flows returned to the treatment process should be monitored and controlled through pH measurements. A high pressure wash of the quartz tubes or teflon-lined channels should be utilized as a follow-up to chemical cleaning. The system design shall provide for direct scrubbing of surfaces and lamp removal for testing of UV output. As UV transmissibility of quartz and teflon will diminish with time, the design should provide for periodic measurements of these values. As continuous methods of cleaning UV lamp and channel surfaces have not been established as reliable means of maintenance, these methods, including mechanical wipers and ultrasonics, shall not be accepted as sole maintenance methods, i.e., they may be used together with conventional maintenance methods as previously described in this section.

F. Hydraulics. The distances across light intensity gradients for flow past UV lamps should be short compared to the length of the chambers in the direction of flow, and measures should be taken to assure mixing across these gradients, with minimal longitudinal mixing, as measured by the dispersion coefficient. UV system design should provide an estimated E value of no more than 100 square centimeters per second.

1. For lamp assemblies with a dispersion coefficient equal to or more than 50 square centimeters per second, the minimum contact period shall be 10 seconds, assuming that the flow path length is equivalent to the linear distance that the design dosage is provided. The contact period of the UV system flow pattern shall be of sufficient duration to provide the design dose response in relation to the established E value.

2. All UV systems shall be furnished with a means for dewatering as necessary for cleaning. The depth of irradiated flow shall be controlled as necessary to meet the disinfection standard at all flow rates.

G. Safety. UV lamps should not be viewed in the ambient air without proper eye protection as required by VOSH and other applicable regulations. A minimum of one pair of UV protective eye glasses shall be provided. The system design should prevent exposure of bare skin to UV lamp emissions for durations exceeding several minutes. Electrical interlocks should be provided to shut off high voltage systems in accordance with VOSH requirements and as requested by other local and state standards when such energized connections are exposed and could come into contact with operators.

H. Monitoring. Facilities shall be included for collecting a sample following the contact period prior to discharge, to determine the effectiveness of the disinfection method.

1. As most UV disinfection equipment represents new technology and limited performance data is available for these systems, an initial period of increased sampling frequency and testing requirements for pathogenic bacterial indicators, such as fecal coliform, may be required. The required initial testing program should take place over a period of one year or more under reasonable operating conditions with a minimum sampling frequency of at least once per week.

2. Disinfection of secondary effluent by UV irradiation should consistently maintain a fecal coliform level below 200 organisms per 100 milliliters of sample or the level established by the permit or certificate issued.

3. Indicator organism test results should be correlated with other measurements at the time of sampling, including flow rate, effluent suspended solids, UV absorbance coefficient, and lamp operating conditions such as total operating time, the number in operation, and voltage and intensity.

9 VAC 25-790-780. Ozonation.

A. Disinfection can be achieved through microorganism exposure to a sufficient level of Ozone (O3) in solution for a proper contact period. Ozone is an unstable gas that is produced when oxygen molecules are dissociated into atomic oxygen which subsequently collides with other oxygen molecules.

B. Parameters. The following parameters are important factors in the design of ozonation disinfection:

1. The applied ozone dosage is the mass of ozone from the generator that is directed to a unit volume of the wastewater to be disinfected.

2. The transferred ozone dosage is the mass of applied ozone that is dissolved into the wastewater. This dosage depends on the physical characteristics of the contractor and the residual ozone concentration, which is affected by the quality of the wastewater.

3. The dew point is the measure of the relative moisture content of a gas, specifically the temperature at which a gas under a precise pressure is saturated with water.

4. Off-gas is the excess ozone transferred from the contact basin to the surrounding atmosphere.

5. Ozone destruction involves the changing of ozone to a less reactive molecule. This occurs naturally because of ozone's inherent instability. However, deactivation by thermal or catalytic destruction units is usually necessary to reduce excess ozone in the off-gas to acceptable levels for human health.

6. Dose/response curve is a mathematical relationship between coliform destruction and transferred ozone dosage. A threshold level of dosage may exist that indicates no response until the dosage exceeds that threshold.

C. Design. This process can be considered for disinfection of filtered secondary effluents. Documentation of process effectiveness must be provided for ozone disinfection of secondary effluents that are not filtered. The transferred ozone dosage shall exceed the threshold level as necessary for adequate disinfection. The presence of reducing compounds such as nitrates shall be addressed in the unit operation design.

1. The contact basin design shall ensure uniform mixing of ozone with the wastewater as well as flow retention equal to or exceeding the design contact period. Ozone addition shall be staged to provide a uniform ozone concentration throughout the entire volume of the contact basin. Multiple staged contactors that are positively isolated from each other are recommended. The design shall provide continuous disinfection while contact basins are dewatered for cleaning and shall include provisions for foam control, including adequate collection space and a removal mechanism. In addition, the design (flow path width to length ratio of 20 or more) shall minimize short-circuiting and optimize the contact period through the provision of baffles or other approved methods. A minimum contact period of 10 minutes shall be provided at average daily flow.

2. Ozone recycling and destruction shall be considered.

a. Moisture and foam removal should be considered in the design of catalyst type destruction units.

b. The use of activated carbon for destruction is not recommended.

c. A pressure/vacuum relief valve is required between the destruction unit and the contact basin to protect the contact basin from excessive pressure or vacuum.

3. Generation and feeding equipment shall be capable of providing disinfection, as specified by the issued certificate or permit, under variable operating conditions such as peak flows and ozone demand.

D. Ozone supply. Ozone production shall be sufficient to disinfect to achieve effluent disinfection requirements at the maximum daily wastewater flow. The applied ozone dose shall produce the design transferred ozone dosage at the calculated transfer efficiency. Pilot scale tests or development of a dose/response curve from the current literature shall be provided to establish the design transferred ozone dose.

1. The ozone generator should produce the design ozone concentration while operating at 75% or less maximum power to reduce stress on generator dielectrics and decrease maintenance problems. Likewise, high voltages and frequencies should be avoided.

2. The ozone generator design shall provide for cooling. Watercooled systems are recommended. The effectiveness of air cooled systems shall be verified.

3. The feed gas shall be oil-free, particle-free and dry. Pure oxygen normally has these characteristics. If air feed is used, the following shall be required:

a. The feed gas shall be filtered or electrostatically precipitated so that it does not contain particles greater than 0.4 microns in diameter.

b. The feed gas moisture content shall not be greater than 0.011 grams per cubic meter (dew point temperature of -60°C at standard pressure).

c. Desiccant type dryers shall have a design cycle time of 12 hours or more under maximum moisture conditions.

d. Feed gas dryers shall have a source of purge flow that is monitored and controlled.

4. Standby ozonation capability shall be provided which will ensure adequate disinfection with any unit out of operation for maintenance or repairs. An adequate inventory of parts subject to wear and breakage shall be maintained at all times.

E. Features. Measurement equipment and alarms shall be provided to ensure proper operation of all system units and continuous disinfection to permit limits under expected operating conditions. Monitoring should be provided for the parameters listed below:

1. Inlet temperature, pressure, flow rate, and moisture concentration of generator feed gas.

2. Outlet temperature, pressure, flow rate, and ozone concentration of generator discharge gas.

3. Frequency, voltage, wattage, and amperage of generator power supply.

4. Inlet flow, and inlet and outlet temperature of generator cooling water.

5. Ozone concentration in contact basin off-gas.

6. Inlet temperature and flow, and outlet ozone concentration of destructor gas.

Materials shall be suitable for use with ozone. Piping systems should be as simple as possible, and specifically selected and manufactured to be suitable for ozone service with a minimum number of joints. Piping should be well supported and protected against temperature extremes.

Requirements for housing shall be the same as for chlorination. Floor space shall be sufficient to provide access for equipment maintenance and to allow adequate equipment ventilation.

F. Safety. Safety requirements shall be the same as for chlorination. Employee exposure to ozone in the working environment is limited by VOSH requirements and such exposure should not exceed the permissible exposure level in VOSH regulation. Monitoring and purging shall be provided to prevent development of an explosive atmosphere in the contact basins and other susceptible areas in accordance with federal and state standards.

G. Monitoring. Monitoring requirements shall be the same as for chlorination.

1. Off-gas ozone monitoring is recommended for use in a control loop. Residual ozone monitoring is not recommended unless its reliability can be documented.

2. Monitoring of the final effluent for a suitable pathogenic bacterial indicator organism, such as fecal coliform, shall be required for a period of at least one year to ensure disinfection effectiveness.

9 VAC 25-790-790. Other disinfection methods.

A. Design standards for disinfection methods not specifically addressed in this chapter will be established upon evaluation of performance data.

B. Chlorine dioxide (ClO_2). Chlorine dioxide is characterized as a yellow-green to orange gas, its color changing toward red with increasing concentration. Upon cooling, it forms a red, highly unstable liquid which freezes at -59°C and boils at 11°C. Due to the sensitivity of ClO_2 gas to pressure and temperature, it shall be generated at the location where it will be used as a disinfectant. Chlorine dioxide is quite soluble in water, its solubility depending upon temperature and pressure. At temperatures less than 25°C and above 30 mm partial pressure, it is soluble to the extent of 10 grams per liter. Unlike chlorine, ClO_2 does not react with water; it is a true dissolved gas.

1. Chlorine dioxide gas is very toxic but, when dissolved, it is stable and safe to use in water solution. Since concentrated chlorine dioxide gas is unstable under pressure, chlorine dioxide shall be generated under controlled conditions.

2. The generation of chlorine dioxide involves the reaction between chlorine and sodium chlorite:

$Cl_2 + 2\ Na\ ClO_2 \text{---->} 2\ NaCl + 2\ ClO_2$

Side reactions that also produce sodium chlorate ($Na\ ClO_3$) are also possible in dilute solutions, especially if the concentration of molecular chlorine, Cl_2, is low. Research has shown that high concentrations of sodium chlorite and molecular chlorine favor the formation of chlorine dioxide. Accordingly, chlorine dioxide generators should be designed and operated to provide these reaction conditions while minimizing the amount of chlorine gas that is mixed with the generated ClO_2.

3. As with chlorine, adequate disinfection with chlorine dioxide is achieved by maintaining a sufficient chlorine dioxide residual after a specific contact time in order to achieve the desired microbiological quality of the treated effluent. All the principles of good chlorination practice, proper pretreatment, rapid initial mixing, adequate residual, plug flow contacting, etc., are also applicable to disinfection with chlorine dioxide.

4. Thus, the required levels of residual ClO_2 shall be equivalent to the residual concentrations that would be required for chlorination of a specific effluent unless adequate information is submitted to the regulatory agencies verifying that acceptable disinfection can be achieved with a lower residual of ClO_2.

5. Design dosages of ClO_2 applied to treated effluent should be similar to the recommended levels for chlorination. The results of limited research to date indicate that for certain effluents, lower dosages of ClO_2, in comparison to Cl_2, may accomplish adequate disinfection. However, all proposals specifying design dosages of ClO_2 below the levels approved for chlorination, must provide supporting information based on field measurements or laboratory studies acceptable to the regulatory agencies.

6. The introduction of ClO_2 shall be in a manner to maximize mixing with the influent flow to the contact basin while minimizing vaporization. The same basic principles as for chlorine are to be adhered to in chlorine dioxide physical

contacting with the wastewater. However, chlorine dioxide use should be optimized by appropriate selection of application points within the process scheme.

7. Contact periods approved for chlorination shall be directly applicable to chlorine dioxide contacting unless adequate supporting information is submitted verifying that the use of a particular design contact period can result in the acceptable level of disinfection.

8. Chlorine dioxide disinfection requires maintenance of a residual throughout the contact period. Conventional amperometric titration systems should be used to monitor chlorine dioxide residuals and, with some modifications, should be used to control the residual and generation of chlorine dioxide. Operator exposure to ClO_2 shall be minimized. Adequate ventilation shall be provided in areas where ClO_2 is generated and where concentrated mixtures of ClO_2 are sampled and tested. As ClO_2 to ambient air mixtures containing 10% or more ClO_2 are potentially explosive and highly corrosive, provisions shall be made to prevent this occurrence.

C. Electrolytic oxidants. Electrolytic processes produce a mixed group of oxidants consisting of ozone, hydrogen peroxide and chlorine constituents. This process is typically monitored and controlled by the chlorine residual level in the wastewater effluent. All electrolytic oxidant processes should be evaluated under the provisions for conventional disinfection of wastewater in accordance with this chapter. The department will evaluate the development of these methods of disinfection and the approval of this process will be handled on a case-by-case basis in accordance with the provisions of this chapter.

9 VAC 25-790-800. Dechlorination.

A. Dechlorination is a process which effectively reduces free and combined chlorine residuals. Sulfur compounds applied to chlorinated effluents have been established as effective dechlorination agents as follows:

1. Sulfur dioxide (SO_2) is a nonflammable, colorless gas with a suffocating, pungent odor and a density greater than that of air. It rapidly dissolves in water to form a weak solution of sulfurous acid (H_2SO_3) which dissociates to produce sulfite ions $(SO_3)^{-2}$, which are the active dechlorinating agents.

2. Sulfite salts used for dechlorination include sodium sulfite ($NaHSO_3$), sodium disulfite (NaHSO3), and sodium metabisulfite ($Na_2S_2O_5$). Sodium metabisulfite is the most commonly used. Sulfite salts are available in dry form and are more safely handled than sulfur dioxide. On dissolution in water they produce the same active sulfite $(SO_3)^{-2}$ ion.

B. Usage. Both sulfur dioxide gas and sulfite compounds may be considered for use for dechlorination purposes. However, the use of sulfur dioxide gas or sodium metabisulfite in accordance with this chapter will be considered as conventional technology for dechlorination of flows equal to one mgd or more.

1. Sulfur dioxide shall be fed as a gas similar to chlorine gas. Since sulfur dioxide is more prone to reliquification, consideration should be given to heating the sulfur dioxide header. Sulfonator capacity shall be adequate to dechlorinate the maximum chlorine residual anticipated on at least a one-to-one basis at maximum daily flow rates to meet the effluent requirements contained in the issued permit or certificate. Requirements for equipment type, standby capability, spare parts, water supply, measurement equipment, control equipment, and evaporators are the same as for chlorination although the materials of construction may differ.

2. Sulfite salts may be fed in dry form with dry chemical feeders or they can be made up as a solution and fed with a diaphragm pump. With either method, proper feed controls shall be provided. Equipment capacity shall be adequate to dechlorinate the maximum chlorine residual anticipated on the basis of 1-1/2 parts or more sulfite salt to one part chlorine.

C. Features. Gas and dry feed equipment requirements shall be similar to those used for chlorination.

1. The dose mixing shall occur following the design chlorine contact period. Normally, this will require the use of a separate basin designed to thoroughly mix the dechlorinating agent with the contact tank effluent within a period of approximately one minute.

2. As the dechlorination reaction is essentially instantaneous, no further contact time is needed other than that required for mixing.

3. Piping materials shall be suitable for use with the sulfur chemical utilized.

4. Housing for feed equipment required shall be the same as for chlorination. However, sulfur dioxide feed equipment and storage containers shall be physically separated by sufficient distance, or by partition barriers, from the chlorination equipment and storage containers in order to prevent cross contamination of feed lines and to satisfy fire codes. Sulfite salts should be stored in unopened shipping containers until ready for use.

D. Safety. Handling requirements shall be the same as for chlorination, except for sulfite salts, which are nonhazardous.

E. Monitoring. Monitoring provisions shall be the same as for chlorination, except that facilities shall also be provided for securing a sample after dechlorination.

F. Other methods. Other means of dechlorination will be evaluated based on submission of adequate performance data.

1. Granular activated carbon may be used for dechlorination of high quality effluents. The dechlorination reaction is dependent on the chemical state of the chlorine, chlorine concentration, flow rate, physical characteristics of the carbon, and wastewater characteristics. Design considerations are similar to those utilized for other wastewater processing unit operations.

2. For small facilities with a design flow less than one mgd, dechlorination may be accomplished through the use of a holding pond such as effluent polishing pond or a constructed wetlands.

9 VAC 25-790-810. Polishing ponds.

A. On-line effluent polishing ponds (OLEPP) can be provided to receive discharges at locations where use of the receiving water requires a degree of performance reliability exceeding that provided by the design, operation and maintenance of the sewage collection system and treatment works. The design and construction of OLEPP's may be similar to that of stabilization ponds.

B. Useage. All sewage treatment works designed to produce a secondary effluent quality of 24 mg/l or more of BOD or suspended solids that discharge to shellfish waters such that shellfish harvesting restrictions may be imposed, shall be provided with an OLEPP, or sufficient off-line emergency storage, unless an exemption is granted by the director subsequent to a public hearing held to discuss the impacts of the discharge. An OLEPP should be required for all sewage treatment works (i) for which the design either does not achieve Class I reliability requirements, or is considered nonconventional in accordance with this chapter; (ii) that discharge to critical waters; or (iii) that are located where water quality conditions dictate the need for maximum protection of public health and welfare.

1. These effluent polishing ponds may be required for any Class I reliability discharge from treatment works that are not daily attended by operational personnel for a minimum period of 16 hours.

2. Those sewage treatment works for which sufficient information is provided to the department verifying that adequate performance reliability will exist in the form of continuously available operational staff and supplemental systems and resources, so that water quality and resources will not be damaged in a manner that produces socio-economic losses, may be granted an exception to the requirements for an OLEPP or emergency storage.

3. An OLEPP can be utilized in instances where an additional removal of BOD_5 and suspended solids up to a maximum of 3.0% is desired from the effluent of a properly operated and properly loaded secondary treatment facility.

4. An OLEPP can be utilized to control residual chlorine through natural processes such as oxidation and UV light irradiation. The chlorine dosage applied to the pond influent shall be monitored and controlled.

5. A closure plan shall be provided in accordance with this chapter and standards contained in this chapter, prior to issuance of an operating permit.

6. Effluent from an effluent polishing pond shall be disinfected in accordance with this chapter, unless adequate disinfection can be provided for the pond influent, so that effluent disinfection is not deemed necessary.

7. Adequate disinfection of a three-day capacity effluent-polishing pond influent may require special consideration such as:

a. A minimum flow path length-to-width ratio within contact tanks of 40:1.

b. Expansion of detention volume to 60 minutes residence time.

c. Use of mixing devices for chlorine dosing to replace or supplement standard diffusers.

C. Design. The actual liquid depth of facultative polishing ponds shall not be less than five feet or more than 10 feet. The detention time shall not be less than one day nor more than three days, based on average daily flow.

1. In most cases, it should be necessary to provide postaeration facilities following facultative polishing ponds to meet effluent dissolved oxygen requirements, due to the depletion of oxygen in facultative ponds. If postaeration facilities are not provided, calculations shall be submitted to show that the required effluent dissolved oxygen concentrations can be maintained on a continuous basis. Postaeration shall occur during or following disinfection.

2. The influent line shall discharge below the liquid level of the pond near the edge of the pond embankment. The influent line shall enter the pond at a point opposite the effluent structure to prevent short-circuiting and to provide maximum detention time.

3. The effluent structure can be a single draw-off type with a draw-off point 12 to 18 inches below the normal liquid level or a multiple draw-off structure.

D. Aeration. The selection of aeration equipment shall be consistent with the depth of the lagoon.

1. The aeration equipment shall be sized to provide uniform dissolved oxygen concentration throughout the pond. Surface aerators should provide a minimum horsepower capacity of 0.01 hp per 1,000 gallons or provide equipment for which existing performance data has shown it to be sufficient to maintain solids in suspension and capable of dispersing the required level of oxygen uniformly. Diffused aeration systems must be adequately located and sized to provide uniform oxygen dispersion and maintain solids in suspension.

2. The number of surface aerators required shall be determined by the circle of influence of the aerator. The circle of influence shall encompass the entire pond and is defined as the area in which the return velocity is greater than 0.15 feet per second as certified by performance data. Without supporting data, the following may be used as a guide.

Nameplate Horsepower	Radius in feet
5	35
10-25	50
40-60	50-100
75	60-100
100	100

E. Features. For aerated OLEPP's the influent sewer shall discharge near one of the mechanical surface aerators. The outlet should be arranged to withdraw effluent from a point at or near the surface. In-pond baffling may be considered to improve hydraulics.

1. A sedimentation zone that has at least 1-1/2 hours of design detention or settling period and a surface loading not to exceed 700 gallons per square foot per day shall be provided. Provisions for sludge removal from the OLEPP, as necessary, shall be addressed in the final design.

2. Either concrete bottom, walls, or embankment walls, or soils-cement stabilization of bottom, walls and embankments should be evaluated in the final design. Earthen embankment walls one foot above and one foot below the normal water level shall be riprapped or stabilized with other suitable material to prevent erosion from wave action.

9 VAC 25-790-820. Postaeration.

A. Postaeration design may involve mechanical aeration, diffused air injection, or cascade type aeration. Other methods may be utilized and will be evaluated on a case-by-case basis by the department.

B. Mechanical aeration. Multiple aeration basins for continuous operability should be provided at all treatment works with a design flow of 40,000 gallons per day or more, unless other means of maintaining an adequate level of dissolved oxygen (D.O.) in the effluent are available.

1. The aeration equipment transfer efficiency shall be determined utilizing the manufacturer's certified rating for the particular equipment being considered. The transfer efficiency shall be adjusted to reflect anticipated field conditions of temperature, atmospheric pressure, initial D.O., and composition of the wastewater being oxygenated. When the detention time within the aeration basin exceeds 30 minutes, consideration shall be given to oxygen requirements resulting from biological activity in the postaeration basin. For aeration basins equipped with a single mechanical aeration unit, a minimum of one mechanical aeration unit shall be maintained in storage at the treatment works site for immediate installation.

2. Aeration basins shall be designed to minimize short circuiting of flow and the occurrence of dead spaces. Vortexing shall be prevented.

C. Diffused aeration. Multiple aeration basins shall be provided for continuous operability of treatment works having a design flow capacity of 40,000 gallons per day or greater, except where diffusers may be removed from the basin for maintenance.

1. Diffused aeration basins shall be designed to eliminate short-circuiting and the occurrence of dead spaces. For maximum efficiencies, sufficient detention time shall be provided to allow the air bubbles to rise to the surface of the wastewater prior to discharge from the basin.

2. When the detention time in the aeration basin exceeds 30 minutes, consideration shall be given to the oxygen requirements resulting from biological activity in the aeration unit.

3. Diffused air aeration systems shall be designed utilizing Fick's Law (the rate of molecular diffusion of a dissolved gas in a liquid) in the determination of oxygen requirements. Supporting experimental data shall be included with the submission of any proposal for the use of diffusers which are considered nonconventional. Such proposals will be evaluated on a case-by-case basis by the department.

4. Blower design shall be such that with any single unit out of operation, the oxygen requirements will be provided for maintaining effluent D.O. A minimum of one standby blower shall be stored at treatment works where single aeration basins are utilized.

D. Cascade type. Effluent aeration may be achieved through a turbulent liquid-air interface established by passing the effluent downstream over either a series of constructed steps, or a rough surface that produces a similar opportunity for transfer of dissolved oxygen to the effluent.

1. The following equation shall be used in the design of cascade type aerators:

$r^n = (C_s - C_a)/(C_s - C_b)$

where: r = Deficit ratio

C_s = Dissolved oxygen saturation (mg/l)

C_a = Dissolved oxygen concentration above the weir, assumed to be 0.0 mg/l.

C_b = Dissolved oxygen concentration in the effluent from the last or preceding step

n = The number of equal size steps

$r = 1 + (0.11)(ab)(1 + 0.046\ T)(h)$

where: T = Water temperature (°C)

h = Height of one step (ft)

a = 1.0 for effluents (BOD of 15 mg/l or less)

= 0.8 for effluents (BOD of 15 mg/l to 30 mg/l)

b = 1.0 for free fall and 1.3 for step weirs

2. The equation for determining the number of steps is dependent upon equidistant steps; and, if unequal steps are used, transfer efficiencies must be determined for each separate step.

3. The effluent discharge to a cascade type aerator shall be over a sharp weir to provide for a thin sheet of wastewater. Consideration shall be given to prevention of freezing.

4. The final step of the cascade type aerator shall be above normal stream flow elevation and the cascade aerator shall be protected from erosion damage due to storm water drainage or flood/wave action.

5. When pumping is necessary prior to discharge over the cascade aerator, multiple, variable speed pumps must be provided except when preceded by flow equalization.

Article 8.
Advanced Treatment.

9 VAC 25-790-830. Flow equalization.

A. Flow equalization is a unit process whereby the variability of wastewater flows, in terms of volume and strength, is lessened. Where flow equalization is utilized within a sewerage system or treatment works to reduce the peak flow conveyed to, or processed by, the treatment works, the performance of the treatment process should be improved in relation to the estimated conventional effluent values. The ability of a treatment works that is provided with flow equalization to meet permit or certificate effluent limitations shall be evaluated on a case-by-case basis.

B. Usage. Flow equalization shall be provided in the flow scheme ahead of advanced chemical-physical processes, unless engineering analysis shows that absence of flow equalization is more cost effective while maintaining the same degree of reliability and operational control.

1. Flow equalization should be provided upstream of biological treatment works designed to process a mean daily flow of 0.1 mgd or less, and receiving hourly peak flows in excess of twice the design flow, if such peak flows will occur daily in excess of 50 times annually.

2. Flow equalization shall be provided upstream of biological treatment works designed to process a mean daily flow of 0.1 mgd or less that are permitted with effluent limitations less than 20 mg/l of BOD_5 or TSS, or a TKN of less than 5 mg/l, or a total phosphorus of less than 2 mg/l, unless approved downstream unit operations are also provided.

C. Design. The design of an equalization basin shall incorporate the evaluation and selections of a number of features as follows:

a. On-line versus off-line basins.

b. Basin volume providing for a total storage detention of one-third or more of the daily design flow.

c. Degree of compartmentalization relative to dry weather and wet weather peak flows.

d. Type of construction: earthen, concrete or steel.

e. Aeration and mixing equipment.

f. Pumping and control in order to uniformly introduce flow into the treatment process at approximately the daily design flow rate during peak flow events.

g. Location in treatment system to provide uniform loadings on downstream unit operations.

The design decisions shall be based on the nature and extent of the treatment processes used, the benefits desired and local site conditions and constraints.

1. The minimum mixing requirements for equalization basins receiving raw or untreated domestic wastewaters or sewage containing an average suspended solids concentration exceeding 45 mg/l, shall equal or exceed 0.02 hp/1,000 gallons at a depth providing at least one-third of the maximum storage volume. Oxygen shall be supplied at a rate of 15 pounds per hour per gallon. Multiple mixing and aeration units shall be provided for continuous operability.

2. Flow equalization basins receiving treated wastewater or sewage with an average suspended solids concentration of 45 mg/l or less shall be provided with a means of sludge removal or mixing equipment that shall have a minimum power input of 0.01 hp/1,000 gallons of maximum storage volume. Aerobic conditions shall be maintained. Multiple mixing and aeration units shall be provided for continuous operability.

3. Sufficient storage shall be provided to allow subsequent downstream unit operations that follow equalization to operate at or less than their ted design capacity.

a. Storage capacity shall be determined from flow data when available. Basin volume for equalization shall at a minimum be determined from an inflow mass hydrograph of the hourly fluctuations for a typical daily wastewater flow, where typical daily wastewater flow is defined as the desired flow rate out of the equalization basin. Additional equalization basin volume shall be provided to accommodate:

(1) Continuous operation of aeration and mixing equipment.

(2) Anticipated concentrated treatment works recycle flows.

(3) Unforeseen changes in diurnal flow.

b. An evaluation of infiltration/inflow shall be conducted where influent flow data are not available. The minimum detention time shall be eight hours of the estimated daily maximum flow as determined by the study.

4. Flow equalization basins with a storage capacity exceeding 20,000 gallons should be constructed as compartmentalized or as multiple basins. Single basin installation with a bypass to downstream treatment units may be used for treatment works with capacities less than 200,000 gpd that are not located in critical water areas. The storage basins shall be provided with the means to be dewatered.

5. Basins designed for a combination of storage of wet weather flows and equalization shall be compartmentalized to allow for utilization of a portion of the basins for dry weather flow equalization. Floating surface aerators shall have provisions to protect the units from damage when the tank is dewatered.

6. Multiple pumping units shall be provided that are capable of delivering flow to an overflow device so that the desired flow rate can be maintained from the equalization basin with the largest pumping unit out of service, unless a suitable gravity flow system is provided. Gravity discharge from equalization shall be regulated by an automatically controlled flow-regulating device. If a flow-measuring device is provided downstream of the basin to monitor and control the equalization discharge, then a raw sewage influent flow meter will not be required in accordance with this chapter.

7. Equalization shall be preceded with screening and should be preceded by grit removal. Facilities shall be provided to flush solids and grease accumulations from the basin walls. A high-water-level takeoff shall be provided for withdrawing floating material and foam.

8. An overflow shall be provided for equalization basins so that such basins are not flooded, and these overflows are transmitted to downstream treatment units prior to the disinfection unit operation.

9 VAC 25-790-840. Chemical treatment.

A. Usage. Chemicals shall be compatible with the treatment works unit operation and have no detrimental effect upon receiving waters. Pilot plant studies or data from unit operations treating design flows of sewage or domestic wastewaters of similar characteristics (organic levels, metal concentrations, etc., within 25% of proposed design) shall be required to determine appropriate chemicals and feed ranges.

1. Space shall be provided where at least 30 days of chemical supply can be stored in dry storage conditions at a location that is convenient for efficient handling, unless local suppliers and conditions indicate that such storage can be reduced without limiting the supply.

2. Liquid chemical storage tanks must:

a. Have a liquid level indicator.

b. Have an overflow and a receiving basin or drain capable of receiving accidental spills or overflows.

3. Powdered activated carbon shall be stored in an isolated fireproof area, and explosion proof electrical outlets, lights and motors shall be used in all storage and handling areas in accordance with local, state and federal requirements.

4. Chemicals shall be stored in covered or unopened shipping containers, unless the chemical is transferred into an approved covered storage unit.

5. Solution storage or day tanks feeding directly should have sufficient capacity for 24-hour operation at design flow.

6. Acid storage tanks shall be vented to the outside atmosphere, but not through vents in common with day tanks.

B. Features. Provisions shall be made for measuring quantities of chemicals used to prepare feed solutions. Storage tanks, pipelines, and equipment for liquid chemicals shall be specific to the chemicals and not for alternates.

1. Chemicals that are incompatible (i.e., strong oxidants and reductants) shall not be fed, stored or handled in such a manner that intermixing of such compounds could occur during routine treatment operations.

2. Provisions shall be made for the proper transfer of dry chemicals from shipping containers to storage bins or hoppers in such a way as to minimize the quantity of dust that may enter the room in which the equipment is installed. Control shall be provided by use of:

a. Vacuum pneumatic equipment or closed conveyor systems;

b. Facilities for emptying shipping containers in special enclosures; or

c. Exhaust fans and dust filters that put the hoppers or bins under negative pressure in accordance with federal and state requirements.

3. Concentrated acid solutions or dry powder shall be kept in closed, acid-resistant shipping containers or storage units. Concentrated liquid acids shall not be handled in open vessels, but should be pumped in undiluted form from original containers to the point of treatment or to a covered day or storage tank.

4. For the handling of toxic chemicals, suitable carts, lifting devices, and other appropriate means shall be provided in accordance with the material safety data sheets and applicable state and federal requirements.

a. Provisions shall be made for disposing of empty containers by an approved procedure that will minimize exposure to the chemical.

b. The transfer of toxic materials shall be controlled by positive actuating devices.

5. Structures, rooms, and areas accommodating chemical feed equipment shall provide convenient access for servicing, repair, and observation of operation.

a. Floor surfaces shall be smooth but slip resistant, impervious, and well drained with a slope of 1/8-inch per foot minimum.

b. Open basins, tanks and conduits shall be protected from chemical spills or accidental drainage.

6. A minimum of two chemical feeders shall be provided for continuous operability. A standby unit or combination of units of sufficient capacity shall be available to replace the largest unit during shutdowns. The entire feeder system shall be protected against freezing and shall be readily accessible for cleaning.

7. Chemical feeders shall be of such design and capacity to meet the following requirements:

a. Feeders shall be able to supply, at all times, the necessary amounts of chemicals at an accurate rate throughout the range of feed.

b. Proportioning of chemical feed to the rate of flow shall be provided where the flow rate is not constant.

c. Diaphragm or piston type positive displacement type solution feed pumps should not be used to feed chemical slurries.

d. The treatment works service potable water supply shall be protected from contamination by chemical solutions or sewage by providing either an air gap between the portable water supply line and solution tank, or a suitable reduced pressure zone, backflow prevention device.

e. Chemical-contact materials and surfaces must be resistant to the aggressiveness of the chemical solutions.

8. Dry chemical feeder systems shall:

a. Measure the chemical volumetrically or gravimetrically.

b. Provide effective mixing and solution of the chemical in the solution pot.

c. Preferably provide gravity feed from solution pots.

d. Completely enclose chemicals and prevent emission of dust to the operation room.

9. Chemical feeders should be reasonably adjacent to points of application to minimize length of feed lines. Chemical feeders shall be readily accessible for servicing, repair and observation. Chemical feeding equipment should be provided with containment barriers or protective curbing so that chemicals from equipment failure, spillage or accidental drainage will be contained. Chemical feed control systems shall provide for both automatic and manual operation including:

a. Feeders that are automatically controlled should provide for reverting to manual control as necessary.

b. The feeders shall be capable or being manually started.

c. Automatic chemical dose or residual analyzers should be considered and, where provided, should include alarms for critical values and recording charts.

10. Solution tank dosing shall provide for uniform strength of solution, consistent with the nature of the chemical solution. Continuous agitation shall be provided to maintain slurries in suspension. Two solution tanks shall be required for a chemical to assure continuity of chemical application during servicing. Tank capacity should provide storage for 24 hours of operation and:

a. Each tank shall be provided with a drain.

b. Means shall be provided to indicate the solution level in the tank.

c. Make-up potable water shall enter the tank through an air gap.

d. Chemical solutions shall be kept covered, with access openings curbed and fitted with tight covers.

11. Subsurface locations for solution tanks shall:

a. Be free from sources of possible contamination.

b. Assure positive drainage for groundwater, accumulated water, chemical spills, and overflows.

c. Be protected from aggressiveness.

12. Solution tank overflow pipes shall:

a. Be turned downward.

b. Have free discharge.

c. Be located where noticeable.

d. Be directed so as not to contaminate the wastewater or receiving stream or be a hazard to operating personnel, in accordance with VOSH requirements.

13. Service water used in the feeder system shall be:

a. From sources acceptable to the department.

b. Protected from contamination by appropriate means.

c. Ample in supply and adequate in pressure.

d. Provided with means for measurement when preparing specific solution concentrations. Where a booster pump is required, duplicate equipment shall be provided.

14. Scales shall be provided as follows:

a. For volumetric dry chemical feeders.

b. Accurate to measure increments of 0.5% of load.

c. For weighing of carboys that are not calibrated volumetrically.

d. For large treatment works, indicating and recording type scales are desirable.

15. Chemical application equipment should:

a. Assure maximum efficiency of treatment.

b. Provide maximum protection of the receiving waters.

c. Provide maximum safety to operators.

d. Assure satisfactory mixing of the chemicals with the wastewater.

e. Provide maximum flexibility of operation through various points of application, when appropriate.

f. Prevent backflow or back-siphonage between multiple points of feed through common manifolds.

g. Provide for the application of pH affecting chemicals to the wastewater prior to the addition of coagulants.

C. Safety. Gases from feeders, storage, and equipment exhaust shall be conveyed to the outside atmosphere, above grade and remote from air intakes in accordance with applicable state and federal requirements.

1. Special provisions should be made as necessary for ventilation of feed and storage rooms in accordance with VOSH and applicable fire code requirements.

2. For each operator who will handle dry chemicals, protective equipment should be provided, including personal protective equipment for eyes, face, head, and extremities, and protective shields and barriers, in accordance with VOSH requirements.

3. Facilities should be provided for eye washing and showering, in accordance with VOSH requirements. Protective equipment and neutralizers shall be stored in the operating area.

9 VAC 25-790-850. Chemical clarification.

A. General design. Design unit operation detention time shall be estimated as the ratio of the design basin volume to the design flow rate (into that basin) unless adequate test data is made available verifying that a different value of detention time can be utilized. Multiple unit operations for mixing, flocculation and clarification, including duplicate basins and equipment used for chemical feeding, controlled mixing and for final clarification, shall be provided as follows:

1. Advanced treatment works having a rated capacity greater than 40,000 gallons per day.

2. Treatment works consisting of physical-chemical unit operations.

3. Unit operations for controlled mixing shall be in series or parallel.

4. Provisions for unit operations to be taken out of service without disrupting operation shall be included.

5. Multiple stage unit operations shall be provided when a conventional operation cannot be achieved otherwise.

B. Mixing. All treatment works shall provide appropriate mixing unit operations upstream from required chemical clarification and filtration unit operations.

Rapid or high intensity mixing may be accomplished either within basins or in-line within closed channels. Basins should be equipped with mechanical mixing devices; other arrangements, such as baffling, are acceptable only under special conditions. Where mechanical mixing devices are utilized, duplicate mechanical mixing units or spare mixing equipment shall be provided.

The rapid or high intensity detention period (T) should not be less than 10 seconds.

1. The design of the rapid mixing unit operations should be based upon the mean temporal velocity gradient (G) (expressed in inverse units of seconds). Typical values for G and T are:

T (Seconds)	G (Seconds $^{-1}$)
10	1,100

20	1,000
30	900
40	790
41	700

For optimization, the design should establish the proper values of (G) and (T) from appropriate test or performance data.

2. Multiple points of application shall be provided to enable the provision of maximum mixing intensity.

3. The physical configurations of the mixing basin shall be designed to eliminate vortexing.

4. The speed variation of rapid mix equipment should be approximately 50% of the average speed requirement range.

C. Flocculation. Flocculation basins shall be designed to optimize the effects of coagulation through increased opportunity for solids contact, and thus inlet and outlet design shall prevent short-circuiting and destruction of the developed suspended particles or floc.

Flocculation and sedimentation basins shall be as close together as physically possible. The velocity gradient of the flocculated water through pipes or conduits to settling basins shall not be greater than the velocity gradient utilized in flocculating the water. Where velocity gradient is not used as a design parameter, the linear velocity in pipes and conduits from the flocculators to the settling basin shall not exceed 1/2 foot per second. Allowances shall be made to minimize turbulence at bends and changes in direction.

1. A drain and overflow shall be provided for each basin.

2. Multiple unit operations shall be provided for continuous operability for design flows greater than 40,000 gallons per day.

3. Baffling may be used to provide for flocculation in small scale unit operations (less than 2,000 gallons in volume).

4. Flocculation basins shall be provided separately from other unit operations except where a reactor clarifier or clarifiers are provided.

D. Low intensity mixing. The minimum detention time for the low intensity mixed volume shall be 20 minutes, unless acceptable operational or test data establishes that adequate flocculation can be accomplished within a reduced detention time.

1. The design of the low intensity or contact type flocculation units shall be based upon the value of the product of the mean temporal velocity gradient times the detention time (GT), which is ordinarily in the range of 20,000 to 200,000.

2. The design should also establish the optimum value of GT for flocculation from appropriate test data. Variable speed drive units shall be designed to allow speed variation throughout the design range.

3. Successive mixed or contact compartments should be provided. Special attention shall be given to providing properly sized ports effectively located between compartments to minimize short-circuiting.

Tapered flocculation should be provided. Wing walls or stators shall be provided to prevent vortexing in basins utilizing vertical shaft flocculators.

E. Conventional clarifiers. Circular clarifiers of the center feed, peripheral feed and spiral flow type will be considered on an individual basis for gravity settling of coagulated and flocculated sewage effluent (chemical clarification).

1. Multiple basins shall be provided as required for continuous operability of treatment works with design flow capacity of more than 40,000 gallons per day or for treatment works utilizing chemical-physical unit operations.

2. The design surface loading (overflow rate) shall be established on a case-by-case basis as a function of the types of coagulants or use of enhanced settling devices or configurations, such as modular tube-type sections utilized within shallow depth clarifiers. Surface loading rates shall not exceed 600 gpd/square foot for alum sludges, 800 gpd/square foot for iron sludges and 1,000 gpd/square foot for lime sludges, in processes utilizing flocculation, unless adequate pilot plant data is presented verifying that higher loading rates are acceptable.

3. Conventional chemical clarification shall provide a minimum of four hours effective settling time unless adequate operational data is submitted to verify that adequate treatment can be achieved at a reduced value of detention time. Effective settling time will be calculated using the settling zone volume of the basins extending from the inlet entrance to the basins to the submerged effluent orifices or weirs.

4. Rectangular sedimentation basins shall be designed with a length to width ratio of at least four to one.

5. Inlets shall be designed to distribute the wastewater equally and at uniform velocities. Open ports, submerged ports, stilling walls or similar entrance arrangements are required. Where stilling walls are not provided, a baffle shall be constructed across the basin in a manner to redirect flow from the inlet and shall project several feet below the water surface to dissipate inlet velocities and provide uniform flows across the basin settling zone.

6. Outlet devices shall be designed to maintain velocities suitable for settling in the basin and to minimize short-circuiting. The use of submerged orifices or submerged weirs shall be provided where flocculation precedes filtration. The maximum velocity gradient in pipes and conduits from the settling basins to the filters shall not exceed that used in the flocculation. Where velocity gradient is not used as a parameter in the design of outlet devices, the linear velocity in pipes and conduits from settling basins shall not exceed one foot per second.

7. The velocity through settling basins shall not exceed one foot per minute. The basins shall be designed to minimize short circuiting.

8. An overflow weir (or pipe) shall be installed to be compatible with the maximum water level desired above the filter media where filters follow sedimentation. The overflow shall discharge with a free fall at a location where the discharge may be observed.

9. Settling basins used for chemical clarification shall be provided with a means for dewatering. Basin bottoms shall slope toward the drain not less than one foot of fall in 12 feet of length.

10. Automatic continuous sludge removal equipment shall be provided for chemical clarification. Provision shall be made for the operator to observe or sample sludge being withdrawn from the clarifier.

11. Consideration shall be given to the provision of control of climatic factors, such as wind and temperature through use of enclosures or superstructures.

F. Reactor clarifiers. Reactor type flocculation and chemical clarification basins may be considered where wastewater characteristics are evaluated by the department and deemed to be uniform.

Reactor clarifiers shall be designed for the maximum uniform flow rate and shall be adjustable to changes in flow which are less than the design rate.

1. Multiple reactor clarifiers are required to maintain continuous operability.

2. For reactor clarifiers a minimum of 30 minutes shall be provided for flocculation and mixing. The clarification detention time shall be established on the basis of the raw wastewater or sewage characteristics and other local conditions that affect the operation of the unit. Based on design flow rates, the minimum detention time shall be two hours for reactor clarifiers.

3. Reactor clarifiers shall be equipped with orifices if they precede filtration. Orifices shall produce uniform rising or overflow rates over the entire area of the tank and shall provide an exit velocity not to exceed one foot per second. Upflow rates shall not exceed one gallon per minute per square foot of area of the horizontal zone of sludge separation (blanket), for the design mode of operation of the clarifier.

4. The following operating equipment shall be provided:

a. A complete set of necessary tools and accessories.

b. Adequate piping with suitable sampling taps so located as to permit the collection of samples of wastewater from critical portions of the units.

c. Conventional equipment to maintain feeding, mixing, and flocculation operation.

5. Weirs should be designed so that surface water does not travel over 10 feet horizontally to the overflow point or tops of weirs (launders). Weir loading shall not exceed 20 gallons per minute per foot of weir length. Where weirs are used they shall be:

a. Adjustable.

b. At least equivalent in length to the perimeter of the tank.

6. Sludge removal design shall provide that:

a. Sludge pipes shall be not less than three inches in diameter and so arranged as to facilitate cleaning;

b. Entrance to sludge withdrawal piping will prevent clogging;

c. Valves are located outside the tank for accessibility;

d. The operator may observe or sample sludge being withdrawn from the unit;

e. Automatic continuous sludge control shall be provided; gravity control should be utilized.

7. Superstructures. Consideration shall be given to providing a superstructure to enclose the reactor clarifier and associated sampling valves and piping.

9 VAC 25-790-860. Filtration.

A. Conventional design standards have been established for effluent filtration following unit operations for equalization, coagulation and chemical clarification. For conventional design, an equivalent level of pretreatment shall be provided. Filtration for other wastewater reuse alternatives and the design for nutrient removal will be evaluated by the department based on an evaluation of performance data. The owner shall accompany a proposal for nonconventional filtration design with appropriate pilot plant data or full scale unit operations data demonstrating acceptable treatment of similar wastewater. The average BOD_5 and suspended solids concentrations applied to the filter should not exceed twice the required values of filtrate BOD_5 and suspended solids concentrations in accordance with the issued discharge permit or certificate limitations.

B. General design. Conventional effluent filtration shall be accomplished at a uniform rate of one to five gallons per minute per square foot of surface area through filter media consisting of a specified depth of the following materials, either as a single media, or as an approved combination of multiple layers: (i) sand; (ii) anthracite; (iii) mineral aggregate; and (iv) other filter media considered on a case-by-case basis.

1. Equipment for the application of chemicals to the filter influent shall be provided if necessary, to enhance suspended solids removal and minimize biological growth within the media.

a. Multiple unit operations for filtration shall be provided to allow for continuous operation and operational variability for a system with an average design of 0.04 mgd or greater.

b. The operating head loss shall not exceed 90% of the filter media depth.

c. Each filter shall have a means of individually controlling the filtration rate.

2. The effluent filter walls shall not protrude into the filter media and the incoming flow shall be uniformly applied to flooded media, in such a manner as to prevent media displacement. The height of the filter walls must provide for adequate freeboard above the media surface to prevent overflows.

3. The filter shall be covered by a superstructure if determined necessary under local climatic conditions. There shall be head room or adequate access to permit visual inspection of the operation as necessary for maintenance.

C. Backwashing. The source of backwash water upflow to cleanse the filter media shall be disinfected and may be derived from filtered wastewater effluent, for all treatment works with an average design flow equal to or greater than 0.1 mgd.

A design uniform backwash upflow minimum rate of 20 gallons per square foot per minute, consistent with wastewater temperatures and the specific gravity of the filter media, shall be provided by the underdrain or backwash distribution piping. The backwash rate may be reduced in accordance with the demonstrated capability of other methods, such as air scour, provided for cleaning of filter media.

1. The design backwash flow shall be provided at the required rate by wash water pumps or by gravity backwash supply storage. Two or more backwash pumps shall be provided so that the required backwash flow rate is maintained with any single pump out of service. Duplicate backwash waste pumps, each with a capacity exceeding the design backwash rate by 20%, shall be provided as necessary to return backwash to the upstream unit operations.

2. Sufficient backwash flow shall be provided so that the time of backwash is not less than 15 minutes for treatment works with design flows of 0.1 mgd or more, at the design rate of wash. A reduced capacity can be provided if it can be demonstrated that a backwash period of less than 15 minutes can result in a similar clean media bed headloss and a similar filter operating period or run time.

3. The backwash control, or valves, as provided on the main backwash water line, shall be sized so that the design rate of filter backwash is obtained with the control or valve settings for the individual filters approximately in a full open position. A means for air release shall be provided between the backwash pump and the wash water valve.

4. Air scouring, if provided, should maintain three to five cubic feet per minute per square foot of filter area for two to three minutes preceding backwash at the design rate.

5. The bottom elevation of the channel or top of the weir shall be located above the maximum level of expanded media during back washing. In addition:

a. A backwash withdrawal arrangement for optimizing removal of suspended solids shall be provided.

b. A two-inch filter wall freeboard is to be provided at the maximum depth of backwash flow above the filter media.

c. A level top or edge is required to provide a uniform loading in gpm per foot of channel or weir length.

d. An arrangement of collection channels or weirs to provide uniform withdrawal of the backwash water from across the filter surface shall be provided.

D. Deep bed filters. The deep bed filter structure shall provide a minimum depth of 8-1/2 feet as measured from the normal operating wastewater surface to the bottom of the underdrain system. The structure should provide for a minimum applied wastewater depth of three feet as measured from the normal operating wastewater surface to the surface of the filter media.

1. Porous plate and strainer bottoms are not recommended. The design of manifold type filtrate collection or underdrain systems shall:

a. Minimize loss of head in the manifold and baffles.

b. Assure even distribution of wash water and a uniform rate of filtration over the entire area of the filter.

c. Provide the ratio of the area of the underdrain orifices to the entire surface area of the filter media at about 0.003.

d. Provide the total cross-sectional area of the laterals at about twice the area of the final openings.

e. Provide a manifold which has a minimum cross sectional area that is 1-1/2 times the total area of the laterals.

2. Surface wash means shall be provided unless other means of media agitation are available during backwash. Disinfected, filtered water or wastewater effluent shall be used as surface wash waters. Revolving type surface washers or an equivalent system shall be provided. All rotary surface wash devices shall be designed with:

a. Provisions for minimum wash water pressures of 40 psi.

b. Provisions for adequate surface wash water to provide 0.5 to 1.0 gallon per minute per square foot of filter area.

3. Deep bed filters shall be supplied with:

a. A loss of head gauge.

b. A rate of flow gauge.

c. A rate of flow controller of either the direct acting, indirect acting, constant rate, or declining rate types.

d. If necessary, continuous effluent turbidity monitoring.

e. A rate of flow indicator on the main backwash water line, located so that it can be easily read by the operator during the backwashing process.

E. Rapid rate filters. The conventional design rapid rate of filtration shall not exceed five gallons per minute per square foot of filter surface area. The selected filtration rate shall be based upon the degree of treatment required and filter effluent quality requirements.

1. A filtration media sieve analysis shall be provided by the design consultant. The media shall be clean silica sand having (i) a depth of not less than 27 inches and generally not more than 30 inches after cleaning and scraping and (ii) an effective size of 0.35 millimeters to 0.5 millimeters, depending upon the quality of the applied wastewater, and (iii) a uniformity coefficient not greater than 1.6.

2. A sieve analysis for supporting media shall be provided for the design. A three-inch layer of torpedo sand shall be used as the supporting media for the filter sand. Such torpedo sand shall have (i) an effective size of 0.8 millimeters to 2.0 millimeters and (ii) a uniformity coefficient not greater than 1.7.

3. A sieve analysis of anthracite media shall be provided for the design, if used. Clean crushed anthracite or a combination of sand and anthracite may be considered on the basis of experimental or operational data specific to the project design. Such media shall have (i) an effective size from 0.45 millimeters to 0.8 millimeters and (ii) a uniformity coefficient not greater than 1.7.

4. Gravel used as a supporting media shall consist of hard rounded particles and shall not include flat or elongated particles. The coarsest gravel shall be 2-1/2 inches in size when the gravel rests directly on the strainer system and must extend above the top of the perforated laterals or strainer nozzles. Not less than four layers of gravel shall be provided in accordance with the following size and depth distribution:

SIZE	DEPTH

2-1/2 to 1-1/2 inches	5 to 8 inches
1-1/2 to 3/4 inches	3 to 5 inches
3/4 to 1/2 inch	3 to 5 inches
1/2 to 3/16 inch	2 to 3 inches
3/16 to 3/32 inch	2 to 3 inches

Reduction of gravel depth may be considered upon application to the department and where proprietary filter bottoms are proposed.

F. High rate gravity filters. The highest average filtration rate shall not exceed six gallons per minute per square foot unless the department can verify that a higher rate meets treatment needs based on evaluation of pilot plant studies or operational data. The selected filter rate shall be based upon the filter effluent quality requirements.

The media provided for high rate filtration shall consist of anthracite, silica sand or other suitable sand. Since certain manufacturers are presently utilizing multiple media and homogeneous media that are proprietary in nature, minimum standards are not established for filter media depth, effective size and uniformity coefficient of filter media, or the specific gravity of that media.

G. Shallow bed filters. The shallow bed filtration rate should not exceed 1-1/4 gallons per minute per square foot and shall not exceed two gallons per minute per square foot of filter area at average design flow.

1. Chlorination prior to shallow bed filtration shall be sufficient to maintain a chlorine residual of one mg/l through the filter for a system with average design flow of 0.1 mgd or greater.

2. Multiple unit operations shall be provided to allow for continuous operability and operational variability.

3. The filter media shall consist of a series of up to eight inch filter increments having a minimum total media depth of 11 inches. The sand media shall have an effective size in the range of 0.40 mm to 0.65 mm and a uniformity coefficient of 1.5 or less.

4. Filter inlets shall consist of ports located throughout the length of the filter.

5. The filter underdrainage system shall be provided along the entire length of the filter so that filter effluent is uniformly withdrawn without clogging of the outlet openings provided for collection and backwash.

6. Duplicate backwash pumps, each capable of providing the required backwash flow, shall be provided.

7. Facilities shall be provided for addition of filter aid to strengthen floc prior to filtration.

8. A skimmer shall be provided for each filter.

H. Pressure filtration. Pressure filter rates shall be consistent with those set forth in gravity filtration. Pressure filter media shall be consistent with that set forth in gravity filtration.

1. For pressure filter operation. The design should provide for:

a. Pressure gauges on the inlet and outlet pipes of each filter to determine loss of head.

b. A conveniently located meter or flow indicator with appropriate information to monitor each filter.

c. The means for filtration and backwashing of each filter individually, using a minimally complex arrangement of piping.

d. Flow indicators and controls convenient and accessible for operating the control valves while reading the flow indicators.

e. An air release valve on the highest point of each filter.

2. The top of the wastewater collection channel or weir shall be established at least 18 inches above the surface of the media.

3. An underdrain system to uniformly and efficiently collect filtered wastewater and that distributes the backwash water at a uniform rate, not less than 15 gallons per minute per square foot of filter area, shall be provided. A means to observe the wash water during backwashing should be established.

4. Minimum sidewall heights of five feet shall be provided for each filter. A corresponding reduction in sidewall height is acceptable where proprietary bottoms permit reduction of the gravel depth.

5. An accessible manhole should be provided as required to facilitate inspections and repairs.

I. Traveling bridge. This type of filter is normally equipped with a shallow bed divided into cells with a continuously operated reciprocating cell-by-cell traveling backwash system. This filter system shall comply with applicable design criteria set forth for shallow bed filters. Use of these filters will be evaluated by the department on a case-by-case basis.

J. Microstraining. Microstraining involves the passing of treated effluent through a horizontally mounted, rotating drum with a filtering fabric fixed to its periphery by a porous screen. Microstrainer equipment is typically used to improve treatment of biologically treated wastewater which has received secondary clarification. Thus, biological attached growth can accumulate on the filter fabric. Means to control such biological growth shall be addressed in the design.

1. The most common screen opening (aperture) sizes are 23, 35 and 60 microns, but other sizes may be available. Normally, the larger sizes are used in cases when only the coarser solids are desired to be removed. The type of mesh weave, when considered in conjunction with aperture size, greatly affects the hydraulic capacity of a microstrainer. Screen size selection must be based on the particle type and size to be removed.

2. Screens are made from a variety of woven metals and nonmetals, with stainless steel being the most commonly used material. Nonmetallic filter cloths are especially suitable for those applications where the presence of corrosive chemicals would be harmful to metallic cloths. Chlorination immediately ahead of microstraining units employing metallic cloths should be avoided.

3. The area of the submerged portion of the screening fabric helps to govern the hydraulic capacity. Normal submergence is 2/3 to 3/4 of the drum diameter. The speed of rotation of the drum should be based on particle type size to be removed. Decreasing the speed of rotation causes increased removal efficiencies but has the effect of increasing the head loss through the filter fabric and decreasing the hydraulic capacity of the unit. The design rotational speed should be about seven rpm.

4. The backwash system should be designed to serve the dual function of applying energy in the form of pressurized washwater spray to the screen to dislodge retained particles and to collect and transport the solids-laden washwater away from the microstrainer. The backwash system shall be designed to minimize splash-over (solids-laden backwash spray water that falls short or long of the washwater collector rather than into the collector as intended). The microstrainer design shall provide for solids retained on the screen which fall back into the drum pool. Backwashing shall be continuous. Backwash water requirements should be based on particle type and size to be removed. The volume of wash water required shall be determined on an individual basis. The normal source of backwash water is the microstrainer effluent collector. Normally only one-half of the backwash water volume actually penetrates the screen; the rest, called a splashback, flows into the effluent section. The backup system should minimize splashback. Increasing the backwash flow and pressure has the tendency to decrease the headloss through the screen. Up to 25% of the total throughput volume may be required for backwash purposes, but averages of 1.0% to 5.0% are typical. Adequate backwash waste storage and treatment facilities should be provided to dispose of the removed materials within the design limitations of other system components.

5. The most suitable pressure differential through the screen shall be determined on an individual basis. Usual pressure differential under normal operating conditions is 12 to 18 inches. The pressure applied to the screen affects the flow rate through the screen. The low pressure requirement is one of the microstrainer's advantages. The secondary effluent should not be pumped, but allowed to flow by gravity to the microstrainer unit to minimize the shear force imparted to the fragile biological floc.

6. Hydraulic capacity of the microstrainer is affected by the rate of clogging of the screening fabric. The accumulation or build-up of attached bio-mass on the screen over time must be prevented. The use of ultraviolet light may reduce the rate of such accumulation. Microstrainers shall not be utilized to treat wastewaters containing high grease and oil concentrations, due to their clogging effects. Iron and manganese buildups also tend to clog the screen. Periodically, the screen must be taken out of service and cleaned. Microstraining units shall be provided in sufficient numbers and capacities to maintain 100% operability of the microstraining process. Automatic control of drum speed and backwash pressure based on head loss through the screen shall be utilized to help overcome this sensitivity problem.

7. Pilot plant studies can be conducted to determine the applicability and design of the microstraining unit to the specific wastewater to be treated. The hydraulic capacity of a microstrainer is determined by the following: head applied, concentration of solids, size of solids, nature of solids, rate of clogging, drum rotational speed, drum submergence, mesh weave and aperture size. These factors are interrelated such that a change in any one of them will cause a change in some or all of the remaining factors.

K. Nonfixed beds and upflow. Continuously backwashed and other nonfixed bed filters are considered as nonconventional technology. Conventional design standards may be established through evaluation of performance data as provided for in this chapter.

L. Membrane, ultra and micro. Filtration of treated effluent through membranes and other media involving molecular sized removal is considered nonconventional technology. Application of this technology will be considered based on evaluation of performance data as provided for in this chapter.

M. Carbon adsorption. Carbon adsorption involves the interphase accumulation or concentration of dissolved substances at a surface or solid-liquid interface by an adsorption process. Activated carbon, which is generally a wood or coal char developed from extreme heat, can be used in powdered form (PAC) or granular form (GAC). Generally, carbon adsorption is used as the polishing process to remove dissolved organic material remaining in a wastewater treated to a secondary or advanced level. Activated carbon adsorption can also be used for dechlorination.

1. Parameters with general application to design of carbon adsorption units are carbon properties, contact time, hydraulic loading, carbon particle size, pH, temperature and wastewater composition, including concentrations of suspended solids and other pollutants.

2. The adsorption characteristics of the type of carbon to be used shall be established. Such characteristics may be established using jar test analyses of various activated carbons in reaction with the waste to be treated. Adsorption isotherms for each form of carbon proposed for use shall be determined. The source and availability of replacement carbon, as designed, shall be addressed.

3. Pilot plant studies shall be performed upon the selected carbon using the wastewater to be adsorbed, where industrial and domestic wastes are present to determine: breakpoint, exhaustion rate, contact time to achieve effluent standards; and if applicable, the backwash frequency, pressure drop through the fixed bed columns, and the carbon regeneration capacity required. Where strictly domestic waste is to be treated, data from similar full scale unit operations or pilot plant data will be acceptable.

4. Where carbon regeneration is provided, carbon loss due to transportation between the columns and regeneration furnace in the range of five to 10 percent total carbon usage shall be considered normal for design. The rate at which carbon will lose adsorption capacity with each regeneration should be established.

5. If fixed-bed GAC carbon columns must be backwashed to remove solids entrapped in the carbon material, then backwash facilities shall provide for expansion of the bed by at least 30%.

6. Carbon adsorption unit operations may be provided in parallel or series. Sufficient capacity shall be provided to allow for continuous operability of the carbon adsorption process.

7. Nonfixed bed carbon adsorption unit operations may be operated in the upflow or downflow mode. Duplicate pumping units shall be provided for such unit operations.

8. Carbon adsorption unit operations should provide for purging with chlorine or other oxidants as necessary for odor and bio-mass control.

Article 9.
Natural Treatment.

9 VAC 25-790-870. Conventional alternatives.

A conventional land treatment system utilizes a secondary process for pretreatment of sewage followed by irrigation, overland flow, or infiltration-percolation (or combination thereof) methods for applying the treated effluent to an approved site. Other natural treatment alternatives such as aquatic ponds and constructed wetlands may provide conventional sewage treatment. Reuse of treated effluents that meet the quality standards established by the DEQ for the reclamation and reuse of wastewater will be governed by DEQ permitting programs. However, the sewage treatment process that produces the reclaimed water will remain subject to evaluation by the department as prescribed by this chapter.

9 VAC 25-790-880. Land treatment.

A. Site specific information shall be submitted with the preliminary proposal in accordance with this chapter and standards contained in this chapter.

Land treatment systems shall have adequate land for pretreatment facilities, storage reservoirs, administrative and laboratory buildings, and buffer zones, as well as the application sites (field area). The availability of this land should be determined prior to any detailed site evaluation. Site availability information should be obtained concerning:

1. Availability for acquisition or acceptable control.

2. Present and future land use.

3. Public acceptance.

B. Site design. Conformance to local land use zoning and planning should be resolved between the local government and the owner. Adjacent owners should be contacted by the applicant to establish whether significant opposition to the proposed location, or locations, exists. Concerns of adjacent landowners will be considered in the evaluation of site suitability. Public meetings may be scheduled either during or after the evaluation of final design documents so that the department can discuss the technical issues concerning the system design through public participation procedures. Public hearings may be held as part of the certificate/permit issuance procedures.

1. The estimated established site size should be calculated using a typical maximum annual loading depth of 36 inches for slow rate systems and a maximum depth of 72 inches per year for high rate systems to compute the field area size. In addition, the buffer zone area should be estimated using a typical distance of 200 feet from the extremities of the field areas to adjacent property lines. This total estimated site area should be available and permission obtained to gain access to the site for field investigations.

2. When investigating a potential site for application of wastewater, there are some limiting factors, including topography, soils, and vegetative growth (crop), which shall be evaluated early to determine site suitability for a land treatment system. This evaluation should be made in two phases: a preliminary phase and a field investigation phase.

3. The preliminary phase of site evaluations should include the identification of the proposed location of the land treatment system on a recent U.S.G.S. topographic map (7.5 minute quadrangle) or acceptable reproduction or facsimile thereof. A property line survey map should also be available for use in identifying the site location or locations.

4. The 100-year flood elevation should be identified and the proposed pretreatment unit processes should be roughly located in relation to elevation.

5. Preliminary soils information should include a soil site suitability map and include information to identify soil textures, grades, drainage, erosion potential, suitability for certain crops, etc. Information on soil characteristics may be available from either the National Resources Conservation Service (NRS) Office, the local Cooperative Extension Service Agent, or the Soil and Water Conservation Nutrient Management Specialist.

6. The field area available for effluent application may be estimated using typical criteria based on topography and soil characteristics. Field areas should be delineated on topographic maps of the proposed land treatment site.

7. The land treatment system design consultant should arrange a Preliminary Engineering Conference (PEC), as described in this chapter, as a final step in the preliminary phase of the site evaluation. The requirements for soil borings and backhoe pits as needed to study soils should be established at the PEC. A site visit should be scheduled at the PEC that involves the appropriate regulatory personnel and the owner and design consultant.

8. The land treatment system design consultant may not wish to conduct detailed field investigations of site topography, hydrology and soil characteristics prior to the site visit by regulatory personnel and their advisors. However, the proposed locations of field areas and pretreatment units should be established and identified during the site visit. The location of any existing soil borings, backhoe pits, springs, wells, etc., should also be identified during the site visit. Soil borings and backhoe pits may be excavated prior to, during and following the site visit as required. The requirements for soil permeability and hydraulic conductivity testing should be developed either during or shortly after the site visit.

9. Applicants for development of all land treatment systems shall be required to submit at least the minimum required information as required for the appropriate certificate/permit to be issued.

C. Site features. The soil at a potential site should be identified in terms of its absorption capacity and crop production classification, which is a function of physical and chemical characteristics. Important physical characteristics include texture, structure and soil depth. Chemical characteristics that may be important include pH, ion exchange capacity, nutrient levels, and organic fraction. The absorption capacity of a soil may be directly related to soil texture and structure. Soil color may provide an indication of the movement of moisture through soil. Hydraulic conductivity may be estimated from in-field tests using acceptable infiltrometer devices. In addition, the absorption characteristics of a soil may be related to its hydraulic conductivity as measured by both in situ and laboratory tests using acceptable procedures (Table 9). The conductivity tests should be conducted in the most restrictive layer within the depth affected by the land application system. Soil productivity and nutrient management characteristics are discussed in the Biosolids Use Regulations (12 VAC 5-585).

1. Soil evaluation for a land treatment system should follow a systematic approach of selecting proper locations for borings or excavations based on topographic position, slopes and drainage. The physical characteristics of site soils should then be verified by an acceptable number of recorded observations that include soil depth to horizon changes, restrictive layers and parent material, color, texture and structure, for borings or excavations to a minimum depth of five feet.

2. If the soil characteristics differ substantially between borings or excavations, without a logical technical reason for the variation, then additional boring and excavation locations should be studied to identify the nature and extent of the changes in soil patterns throughout the proposed site.

3. The soil characteristics of the proposed site should be described by a qualified technical specialist knowledgeable in the principles of soil science, agronomy, and nutrient management. The long-term impact of land application of the treated effluent on site soils and vegetation or crops must be evaluated by the land treatment system design

consultant. Certain minimum soil depths are required for approval of a land application site. The minimum required depth for field areas will depend on the type of land application system as well as the soil characteristics.

4. Representative soil samples shall be collected for each major soil type identified by the field investigation and analyzed for certain parameters in accordance with this chapter.

5. Detailed information on the geologic conditions of the proposed site shall be provided by a geologist or other technical specialist, or specialists, knowledgeable in geohydrologic principles.

a. Detailed information on the site hydrology and groundwater shall be provided by a geologist, hydrologist or other technical specialist, or specialists, knowledgeable in hydrologic principles and ground water hydrology.

b. The depth to the permanent ground water table below the site shall be determined. The location, depth and extent of perched water tables as well as the estimated seasonal fluctuations shall be established. The effect of the permanent and seasonal water tables on performance of the particular land treatment system shall be evaluated by the design consultant.

c. The characteristics of ground water movement under the proposed site should be established and evaluated using piezometer installations or other acceptable methods. The potential impact of the land treatment system on aquifer hydraulics and water quality shall be predicted through the use of modeling and appropriate monitoring devices.

d. The present and planned uses of the aquifer(s) identified as affected by the land treatment system should be determined by the consultant.

D. Land treatment methods. The following methods, or combinations thereof, as regulated by the appropriate permit or certificate, are considered conventional technology in accordance with this chapter:

1. Irrigation--slow rate. Wastewater may be applied by spraying, flooding, or ridge and furrow methods. Irrigation methods are designed not to discharge to surface waters.

2. Rapid infiltration. Wastewater may be applied by spreading and spraying. The system shall be designed to meet all certificate/permit requirements and groundwater standards.

3. Overland flow. This method of wastewater renovation is best suited for soils with low permeability. Generally, a permit or certificate for a discharge to surface waters must be issued.

E. Other alternatives. Natural treatment systems such as aquatic ponds, constructed wetlands and biological/plant filters and other aquatic plant systems are somewhat related to land treatment technology. Natural treatment involves the use of plants in a constructed but relatively natural environment for the purpose of achieving treatment objectives. The major difference between nonconventional natural and conventional treatment systems is that conventional systems typically use a highly managed and controlled environment for the rapid treatment of the wastewater. In contrast, nonconventional natural systems use a comparatively unmanaged environment in which treatment occurs at a slower rate.

1. The use of natural treatment as a part of a land treatment system may take several forms including ponds called "Aquatic Processing Units" (APU). Floating plants such as water hyacinths and duckweed are often used in APU treatment.

2. Constructed wetlands are defined as areas where the wastewater surface is controlled near (subsurface flow) or above (free water surface) a soil or media surface for long enough each year to maintain saturated conditions and the growth of related vegetation such as cattails, rushes, and reeds.

3. Constructed wetlands must provide for groundwater protection and may be used to provide additional treatment to primary, secondary, or highly treated effluents prior to final discharge.

4. Natural (existing) wetlands are considered as state waters and any discharge to them shall be regulated in accordance with an issued discharge permit or certificate.

F. Features. Biological treatment that will produce an effluent either with a maximum BOD_5 of 60 mg/l or less, or be of such quality that can be adequately disinfected, if necessary, shall be provided prior to natural treatment, including use of conventional unit operations prior to the land application of treated effluent and advanced treatment prior to reuse.

Disinfection may be required following or prior to land application and other natural treatment. If spray irrigation equipment is utilized, adequate aerosol management including pre-disinfection shall be provided.

Buffer zones around field areas shall be provided in accordance with the monitored maximum microbiological content of the applied effluent as follows, with no reduction in required minimum distances to water sources and channels:

Fecal Coliform Count [(1)]	Minimum Buffer Distance, Feet

(No./100 mls)	
200 or less	200 [(2)]
23 or less	50 [(3)]
2.2 or less	None, but no application during occupation of field area [(3)]

Notes:

(1) Exceeded by no more than 10% or less of samples tested.

(2) No public use of field areas.

(3) Transient public use may occur after a three-hour drying period following application.

1. The owner shall provide sufficient holding time to store all flow during periods either when crop nutrient uptake is limited or nonexistent, the ground is frozen, surface saturation occurs during wet weather, the ground is covered with snow, or the irrigation site or field areas cannot otherwise be operated. The total volume of holding required shall be based on the storage necessary to provide for climatic conditions and the nutrient management requirements of the field area crop. Operational storage necessary for system maintenance shall be provided. Climatic holding periods shall be based on the most adverse conditions of freezing and precipitation, as taken from accurate recorded historical data that are available for the local area (in no case less than 25 years). The storage volume shall be sufficient to prevent any unpermitted discharges to state waters.

2. A minimum holding period of 120 days shall be required when climatic data is not available. System backup storage shall be determined by the complexity of the entire treatment system. An increase or reduction of minimum storage may be considered on a case-by-case basis based on adequate documentation of agronomic crop production and nutrient utilization.

3. The depth of the volume containment for total storage requirements shall be measured above any minimum depth requirements for maintenance.

4. The owner shall provide a minimum reserve area equivalent in size to 25% of the design field area. Additional reserve area may be required as evaluated by the division, if the general conditions of the field area are deemed marginal or in proximity of critical areas or waters. The reserve area shall be capable of being used as a functional area within 30 days of notice.

5. Some allowance for a reduced reserve shall be allowed if additional storage is provided or if there is an alternate treatment mode (e.g., discharge) that can be utilized by the facility.

6. Design criteria for treatment or storage ponds shall be in accordance with this chapter and standards contained in this chapter. In addition, the following requirements shall be met:

a. A minimum operational water depth shall be maintained.

b. Provisions shall be made to allow complete drainage of the pond for maintenance.

c. Duplicate pumps shall be provided if necessary to transport pond flows, with the capacity of each pump sized to handle the maximum rate of flow plus an allowance to deplete stored volumes.

d. Disinfection may be provided either upstream from ponds, or the pond effluent may require disinfection.

e. When chlorination is utilized to disinfect pumped flows, the detention time of the holding pond chlorination facilities shall provide a minimum of 30 minutes of contact time, based on the maximum design pumping rate in accordance with this chapter and standards contained in this chapter.

G. Design loadings. Loading rates shall be based on the most critical value as determined by the liquid and nutrient application rates, or total application amounts for other constituents (such as boron, salts, pH-alkalinity, copper or sodium, etc.), present in such concentrations as could produce pollution of either the soil, cover crop, or water quality. Total weekly application (precipitation plus liquid loading rate) shall not exceed two times the design loading rate. This higher than conventional loading rate shall be used only to balance seasonal water deficits, and groundwater quality standards shall not be exceeded unless a variance to the violated standard has been approved by the State Water Control Board.

1. An overall water balance shall be investigated in accordance with one of the following equations based on design criteria:

a. Irrigation or infiltration

design precipitation + effluent applied = evapotranspiration + hydraulic conductivity.

b. Overland flow

design precipitation + effluent applied = evapotranspiration + hydraulic conductivity + runoff.

2. Design precipitation shall be the wettest year for a 10-year period (return frequency of one year in 10). Minimum time period for this analysis should be 25 years. Average monthly distribution (average percentage of the total annual precipitation that occurs in each month) shall be assumed.

3. Design evapotranspiration (monthly) shall be 75% of average monthly pan evaporation values collected at official weather stations within or contiguous to the Commonwealth of Virginia and should be representative (similar geographically and climatological) of the proposed site.

4. Design hydraulic conductivity shall be a given percentage (see Table 9) of respective laboratory and field measurements that yield the rate at which water passes through the soil under presoaked conditions.

The test methodology should be in accordance with current published procedures made available to the department.

TABLE 9.
DESIGN HYDRAULIC CONDUCTIVITY.

Type of Test	Percent of minimum measured value to be used in design
i. Saturated Vertical Hydraulic Conductivity	7
ii. Basin Infiltration	12.5
iii. Cylinder Infiltrometers	3
iv. Air Entry Permeameter	3
v. (Other - to be evaluated by the department)	

5. During periods of application, the applied nitrogen shall be accounted for through (i) crop uptake and harvest; (ii) denitrification; (iii) addition to surface water and ground water, or storage in soil. In winter, site loadings for slow rate systems shall not exceed the hydraulic design for those particular months. Winter application of treated effluent may be provided only (i) to cool season grasses (ii) following three consecutive days of minimum daily temperatures in excess of 25°F and maximum in excess of 40°F.

6. The annual liquid loading depth for plant nitrogen requirements shall be determined by the following equation:

$L = N/2.7C$

Where:

N = Crop nitrogen uptake, lb/acre/yr.

C = Total nitrogen concentration, mg/1

C = TKN + NO2-N + NO3-N

L = Annual liquid loadings depth, ft/yr.

TKN = Total KJELDAHL nitrogen = organic N + NH_3 - N

7. The monthly nitrogen loading rate design should be distributed over the growth cycle of the particular crop, as much as practicable.

8. If other nutrients, organics, or trace elements are present in concentrations critical to either crops, soil, or water quality, then a total mass balance similar to that for nitrogen shall be investigated for each critical element or compound.

9. The land application design average rate shall be determined by the climatic conditions, selected crops, and soil characteristics. However, the maximum application rates in terms of depth of effluent applied to the field area shall be as follows:

a. One-fourth inch per hour.

b. One inch per day.

c. Two inches per week (one inch per week in forest field areas used for year round application).

H. Field area design. Field area is defined as the area of land where renovation of wastewater takes place (area under actual spray or distribution pattern). The field area shall be designed to satisfy the most critical loading parameter (i.e., annual liquid loading depth) according to the following equation:

Field Area (acres) = Q/D*365/(365-S)

Where: Q = Wastewater flow in (acre-inches/week)

D = Applied depth in inches/week

S = Minimum required storage capacity + annual resting periods during the application season when no waste can be land applied.

1. The minimum storage capacity shall be the average design volume of flow accumulated over a period of 60 days, unless other storage periods are justified by climatic data. It should be noted that the field area equation does not take into consideration the area needed for reserve capacity or future expansion (no less than 25% of design field area).

2. The field area shall be divided into smaller sections for application to allow for rotational use of these sections. Rotational operation shall be designed to provide the maximum resting periods for field areas. The distribution system shall be designed to meet the requirement for alternating application to the field area sections. Minimum resting periods shall be two days, one day and two weeks for irrigation, overland flow and infiltration-percolation, respectively. Maximum wetting period shall not exceed five days, one week, and one day respectively for irrigation, infiltration-percolation, and overland flow, respectively. Resting and wetting periods depend on soil types, climatic conditions, harvesting requirements, etc.

3. The field area or areas shall be adequately enclosed with suitable fencing to prevent access to livestock and the public where necessary. Signs shall be posted at sufficient intervals (100 to 300 feet) around the entire perimeter of field areas to identify the land treatment operation and specify access precautions.

4. A groundwater monitoring system shall be provided in accordance with the permit or certificate requirements. A minimum of one upgradient and two downgradient monitoring wells shall be provided. The well locations, along with typical well construction specifications, shall be submitted with the proposal. Upon installation, the driller's log shall be submitted. Additional monitoring well locations may be required if deemed necessary upon evaluation of monitoring data. The results of any required sampling and testing of groundwater shall be submitted to the department for evaluation in accordance with the operating permit.

5. Representative agriculturally related soil tests are required on crop dependent systems to ensure adequate vegetative cover. The growing and maintaining of a vegetative cover on application sites is a very integral part of the system. The plants prevent soil erosion and utilize nutrients and water. The system design should provide for a proper balance between applied amounts of water and nutrients. The designer may wish to consult with both agronomic and nutrient management specialists on these matters. The design shall address crop and nutrient management.

6. The wastewater application schedule should be worked around the plans for harvesting. A minimum of 30 days shall be required between the last day of application and utilization of all crops. Crops that will be consumed raw by man shall not be grown in land application field areas.

7. Information on the proposed crops and their intended use may be forwarded to the Virginia Department of Agriculture and Consumer Services for evaluation.

I. Low intensity design. The low intensity application or irrigation field area should be as flat as possible with maximum slopes of 5.0% or less. The design of low intensity irrigation of treated effluent shall provide for nutrient management control. When it is necessary to locate field areas on slopes of eight to 12%, special precautions shall be taken to prevent seepage or runoff of sewage effluent to nearby streams. Dikes or terraces can be provided for field areas, together with runoff collection and return pumping equipment. The maximum field area slope should be 12%. The irrigation field area shall be located a minimum distance of 50 feet from all surface waters.

1. Five feet of well-drained loamy soils are preferred. The minimum soil depth to unconsolidated rock should be three feet. The hydraulic conductivity should be between 0.2-6 inches/hour.

2. The minimum depth to the permanent water table should be five feet. The minimum depth to the seasonal water table should be three feet. Where the permanent water table is less than five feet and the seasonal water table is less than three feet, the field area application rate shall be designed to prevent surface saturation. In addition, underdrain and groundwater pumping equipment may be required.

3. The method of applying the liquid to the field shall be designed to best suit prevailing topographic, climatic, and soil conditions. Two methods of application are:

a. Sprinkler systems with low trajectory nozzles or sprinkler heads to uniformly distribute the applied effluent across a specified portion of the field area. Application is to be restricted in high winds that adversely affect the efficiency of distribution and spread aerosol mists beyond the field areas.

b. Ditch irrigation systems that utilize gravity flow of effluent through ditches or furrows, from which effluent percolates into the soil. For uniformity of distribution, the slope of the field area is to be uniform and constant.

4. The height of spray nozzles, pressure at the spray nozzles and spacing of the laterals shall be adequate to provide uniform distribution of the effluent over the field area. The design height and pressure of the spray nozzles shall avoid damage to vegetation and soil.

5. Adequate provisions shall be made to prevent freezing and corrosion of spray nozzles and distribution lines when the system or a section of the system is not in operation.

6. Appropriate vegetation shall be maintained uniformly on all field areas. Usually water tolerant grasses with high nitrogen uptakes are used. Over seeding with cool season grasses may be necessary during the fall season, prior to October 15 of each year. Silviculture sites and reuse irrigation sites may also be used with this type of land treatment.

J. Rapid infiltration. This form of treatment requires the least amount of land. Renovation is achieved by natural, physical, chemical, and biological processes as the applied effluent moves through the soil. Effluent is allowed to infiltrate the soil at a relatively high rate, requiring a field area with coarse grained soils. This system is designed for three main purposes (i) ground water recharge; (ii) recovery of renovated water using wells or underdrains with subsequent reuse, or (iii) discharge and recharge of surface streams by interception of ground water.

1. Five feet of sand or loamy sand is preferred. Soil grain size should be greater than.05 mm in size. The hydraulic conductivity should be greater than two inches/hour.

2. The permanent ground water table shall be a minimum of 15 feet below the land surface. With this method, a recharge mound is not uncommon and shall be properly evaluated by the consultant. A minimum distance of 10 feet should be maintained between the land surface and the apex of the recharge mound (during a worse-case situation). Lesser depths may be acceptable where under drainage is provided.

3. Spreading and spraying are the two main application techniques that are suitable for infiltration-percolation.

4. Design application rates will vary according to the site area, soil, geology, and hydrology characteristics.

5. The buffer distances from extremities of field areas to private wells should be at least 400 feet.

K. Overland flow. Renovation of wastewater is accomplished by physical, chemical, and biological means as applied effluent flows through vegetation on a relatively impermeable sloped surface. Wastewater is sprayed or flooded over the upper reaches of the slope and a percentage of the treated water is collected as runoff at the bottom of the slope, with the remainder lost to evapotranspiration and percolation. Overland systems should be capable of producing effluent at or below secondary level; however, additional treatment units may be needed to achieve the permitted effluent limitations.

1. Soils should have minimal infiltration capacity, such as heavy clays, clay loams or soils underlain by impermeable lenses. The restrictive layers in the soil should be between one to two feet from the surface to maintain adequate vegetation. The hydraulic conductivity should be less than 0.2 inches/hour. Field area slopes shall be less than 8.0%. Monitoring wells shall be provided.

2. Renovated water shall be collected at the toe of the slope in cut off ditches or by similar means and channeled to a monitoring point and disinfected as required.

3. The effluent application method should achieve a sheet flow pattern that will produce maximum contact between the applied wastewater and the soil medium. This can be accomplished by lateral distribution methods, low pressure sprays and moderate to high pressure impact sprinklers discharging onto porous pads or aprons designed to distribute the applied flow while preventing erosion. Maximum application rates in terms of depth of effluent should be less than 10 inches per week.

4. Perennial field area vegetation shall be required. Hydrophilic or water tolerant grasses are usually grown with this type of system.

L. Alternative design. Information submitted for approval of other natural treatment systems and reuse alternatives shall include performance data obtained from either full-scale systems similar to the proposed design, or pilot studies conducted over a testing period exceeding one year, to a period of two years, based on test results.

Special consideration should be given to the following factors in planning and design of natural systems:

1. Many aquatic plants are sensitive to cold temperatures and may require the use of a protected environment or operation on a seasonal basis. Some plants may be considered unacceptable for use and their growth must be controlled.

2. Control of insects, particularly mosquitoes, is normally required for constructed wetlands and aquatic plant systems. The use of mosquito-eating fish and water depth adjustments are recommended.

3. Some constituents which may be present in wastewaters, particularly those having high industrial loads, are toxic to many aquatic plants. Therefore, tests should be conducted to identify possible toxics prior to selection of the aquatic plant species.

4. Natural systems utilize a higher life form of less diversity than found in more conventional biological treatment systems. This lack of biological diversity may reduce treatment performance. Constructed wetland and aquatic plant systems could be more susceptible to long term process upsets. Therefore, the effects of fluctuations in climate and wastewater characteristics is extremely important in the design of natural systems.

5. Some aquatic plant and animal species have the potential to create a nuisance condition if inadvertently released to natural waterways. Federal, state and local restrictions on the use of certain aquatic plants and animals shall be considered.

6. Harvesting and the use or disposal of aquatic plants should result in removal of organics, solids and nutrients such as nitrogen and phosphorous from the APU effluent. Management of residual matter shall be in accordance with this chapter and standards contained in this chapter.

9 VAC 25-790-890. Constructed wetlands.

A. Design. These unit operations typically consist of inundated or saturated media supporting flora and fauna typically found in natural wetlands. Two basic designs are referred to as submerged flow systems (SFS) and free water surface systems (FWS). Terms that are also considered synonymous with these systems include (i) rock-plant filters; (ii) marsh-reed filters; (iii) microbial rock-plant filters; and (iv) artificial wetland bio-reactors.

1. The design of constructed wetlands is considered nonconventional technology. Design loading values shall be established in accordance with the type of treatment proposed, established performance data, and site specific features. The use of indigenous wetland flora is recommended provided that those species proposed have been evaluated as suitable for such use by technical experts qualified to make such judgements. Certain flora and fauna may be restricted for use in constructed wetlands.

2. All constructed wetlands shall be preceded by pretreatment of sewage, established as at least equivalent to primary treatment in accordance with this chapter and standards contained in this chapter. Constructed wetlands may be preceded by secondary or better treatment when used for effluent polishing, nutrient reduction, or advanced treatment.

3. The design of individual constructed wetlands shall provide the appropriate features specified for pond treatment systems in accordance with this chapter. Required detention times may vary from one day to 20 days or more, in accordance with the type of pretreatment and the issued permit or certificate effluent limitations.

4. The following factors shall be considered in the selection of the design hydraulic and organic loadings: strength of the influent sewage, effectiveness of primary or secondary treatment, type of media, ambient wastewater temperature for winter conditions, and treatment efficiency required.

5. For design flows of 0.1 mgd or more, the treatment system shall be divided into multiple units that can be operated separately. Each unit shall have the ability to be sufficiently drained for operational maintenance. Design considerations may include parallel treatment streams or trains that can be operated independently of each other.

6. The constructed wetland units shall be designed to operate with plug flow type hydraulics. A proper length to width ratio to achieve this condition should be considered in the design of each system. The inlet design shall provide for proper distribution of the influent.

7. All treatment units shall be provided with outlets that can withdraw flow at various depths (a minimum of three). FWS outlets shall be submerged and be able to exclude floating detrital material and scum.

8. The design shall allow for each unit to be taken out of service at any time and its flows routed to another unit. The treatment system must be capable of treating the daily average flow with the largest unit out of service.

9. All FWS systems shall be situated so as to minimize the adverse effects of the prevailing winds.

10. All systems should maintain a minimum slope along the bottom of at least 0.075% to facilitate draining.

11. Constructed wetland design should allow inlet and outlet depth levels to be raised and lowered in order to (i) vary water levels within the unit basin; (ii) provide the ability to flood the media surface when necessary; and (iii) to drain the unit basin sufficiently for maintenance.

B. Features.

1. SFS systems should be designed to prevent uncontrolled surface ponding of wastewater. Design flow depths exceeding 24 inches shall be justified by evaluation of adequate performance data. The hydraulic loading of these systems should be limited to the effective hydraulic capacity of the media in place. The effective hydraulic capacity will be a function of the clean media's hydraulic capacity reduced by root intrusion, biological slime layer, detritus, algae, and other blockages. Hydraulic loadings exceeding one gallon per day per square feet of total surface area shall be substantiated by evaluation of adequate performance data.

2. FWS systems should be designed to prevent scour, erosion, and plant damage during peak flow periods. Design flow depths exceeding 12 inches shall be justified by an evaluation of adequate performance data. The hydraulic loading of these systems should be limited to the open channel carrying capacity of the unit at full growth. Design organic loadings exceeding 10 pounds of influent BOD_5 per day per acre of surface area shall be substantiated by evaluation of adequate performance data.

3. The flow pattern and depth shall provide for a uniform environment and growth conducive to wetlands.

4. Plants should be placed no greater than 66-inches apart (center to center). All plants to be used should be healthy, insect free, and undamaged. A broad diversity of plant species within any unit is recommended. Harvesting of dead wetland vegetation and detritus plant matter is recommended.

5. The following specifications shall be considered as minimum requirements for material specifications of constructed wetlands rock media:

a. Crushed rock, slag or similar media should not contain more than 5.0% by weight of pieces whose longest dimension is three times its least dimension. The rock media should be free from thin, elongated and flat pieces and should be free from clay, sand, organic material, or dirt. The media should have a Mohs hardness of at least 5.0.

b. Rock media, except for the top planting layer, should conform to the following size distribution and gradation when mechanically graded over a vibrating screen with square openings:

(1) Passing six-inch sieve--100% by weight;

(2) Retained on two-inch sieve--90-100% by weight;

(3) Passing one-inch sieve--<0.1% by weight.

c. Rock media shall be rinsed or washed to remove sediment. This washing should be sufficient to remove any significant amounts of dirt or accumulated debris. The proper placement and installation of media is vital to the success of the system. Undue compaction exerted on the media's surface, as it is installed and after its installation, can fracture and consolidate the media. The introduction of foreign fine particles and fracturing can adversely affect the system's hydraulic conductivity. Therefore, the following guidelines are recommended:

(1) A layer of smaller rock (0.5-1.0 inches) may be used on the top of the unit to ease planting of the vegetation and aid in vector control.

(2) Media should be uniformly placed avoiding compaction.

(3) Compacting operations should not be allowed on the surface of the media after final placement.

(4) Depressions shall be leveled and smoothed over to prevent ponding.

(5) Provisions should be made prior to planting to provide water and nutrients to the plants if the system start-up will be delayed.

6. Other media specifications shall be in accordance with filtration standards as provided in this chapter.

C. Performance.

1. The total suspended solids (TSS) removal efficiency of the constructed wetland units is dependent on the quiescence of the flow through the units. However, if the facility is unable to meet its permitted parameters, alternate means of solids removal must be pursued.

2. Current constructed wetland technology has not demonstrated the ability to consistently nitrify typical domestic strength sewage influent to meet average flow permit limitations below 5 mg/l of ammonia. The design of any constructed wetland to achieve a permit or certificate effluent limitation of 5 mg/l, or less, of ammonia, shall consider the use of a separate nitrification process.

3. The performance of constructed wetlands is a function of the primary or secondary treatment efficiency preceding the units, i.e., fraction of remaining BOD_5 and TSS.

Article 10.
Nutrient Control.

9 VAC 25-790-900. Nutrient reduction.

A. The goal of nutrient reduction is to produce an effluent quality to meet effluent limitations for phosphorus, ammonia nitrogen and total Kjeldahl nitrogen (TKN). All designs should be based on pilot plant studies or full scale operating data obtained at design loadings.

The following nutrient control processes will be considered:

1. Natural Systems--Aquatic plant removal (APU) and proper plant management.

2. Suspended growth systems with adequate sludge treatment and management.

3. Attached growth system.

4. Covered anaerobic ponds.

5. Packed bed filters.

B. Aquatic plant systems. This natural treatment process involves three phases: aquatic plant growth, harvesting and management. Design should be based on seasonal climate and available sunlight in accordance with the provisions of this chapter. The basin or channel shall be based on achieving the required removal rate at the minimum encountered liquid temperature and shall include sufficient capacity to achieve permit requirements during periods of low temperatures and little or no sunlight.

1. It has been reported that for maximum nitrogen assimilation, theoretical detention times vary from days to weeks. The detention time is considered directly related to pond immersion temperatures (between 12°C and 25°C) and independent of temperature between 25°C and 33°C. Detention time can be shortened by biomass control.

2. Culture depths should be established to achieve optimum nitrogen assimilation. Adjustments in detention time should be considered for the variation in culture depth. Basin or trench depth should be as shallow as possible and be designed to prevent seasonal performance problems.

3. Facilities should be provided for the addition of nutrients, such as carbon dioxide, iron and phosphorus, as required.

4. Plant harvesting is the primary means of biomass control but can also serve to remove suspended solids and chemical precipitants. Harvesting of aquatic plant biomass is divided into three phases: concentration, dewatering and drying. Biomass concentrations of 1.0% to 2.0% by weight can be achieved by either coagulation, flocculation and sedimentation by various coagulants and by use of gravity filters (e.g., Sandborn Filter) with filtrate return. Further concentration to 10% to 20% solids is possible with dewatering by filtration or by self-cleaning centrifugation. Microscreens and upflow clarifiers are not recommended because of operation problems and design deficiencies.

5. Biomass control can be accomplished by use of fixed scrapers or floating harvesters with water surface barriers, or by providing settling areas in basins or other flow channels from which the plants are harvested.

6. Drying of harvested plants can be accomplished by air drying on asphalt pavement or other suitable pavement that will allow mechanical spreading and collections. Drainage should be returned to the treatment works.

7. Biomass management includes (i) disposal through incineration and landfill (may be subject to permit or certificate issuance); (ii) reuse through processing as a high protein animal food supplement and (iii) agricultural use as a soil conditioner or fertilizer.

C. Biological nutrient removal.

1. Phosphorus removal. Phosphorus control typically involves the use of activated sludge biomass exposed to varying levels of dissolved oxygen. Anaerobic conditions select organisms that release phosphorus and store carbonaceous substrate. Biomass is processed through anaerobic conditions to a combination of anoxic and aerobic conditions. The subsequent exposure to dissolved oxygen results in biological metabolism of stored organics with subsequent uptake and storage of phosphorus by the biomass.

a. Anaerobic conditions are defined as a reactor volume containing less than 0.2 mg/l of both dissolved oxygen and nitrate-nitrogen. This selection may be provided within a reactor or reactors (mainstream processes) utilizing controlled recycling of activated sludge. Processed flows from additional treatment operations (sidestream processes) may also be utilized.

b. The efficiency of biological phosphorus removal is highly dependent on the influent levels of phosphorus and biodegradable substrate (BOD or COD). The optimum ratio of process influent total (five-day) BOD to phosphorus appears to be approximately 20 to achieve final effluent levels of phosphorus of one mg/l or less.

c. It is necessary to reduce dissolved oxygen and nitrate levels within influent and recycled flows to the anaerobic reactor to levels that will not exceed a level of 0.2 mg/l within the anaerobic biomass. The anaerobic reactor should be subdivided into two or more compartments with a total hydraulic retention time of one hour or more. The anaerobic fraction of the process biomass should not be less than 25% of the total. An operating mean cell residence time of 10 days or more should be provided for optimum phosphorus removal.

d. For final effluent limitations requiring less than three mg/l of total phosphorus, the need for effluent filtration, or chemical addition, to remove suspended solids shall be evaluated.

2. Nitrogen removal. This process involves activated sludge biomass subject to anoxic conditions to promote the reduction of nitrate nitrogen to nitrogen gas that escapes to the ambient air.

a. Anoxic conditions are defined as a dissolved oxygen level of 0.2 mg/l or less and a nitrate nitrogen level exceeding 0.2 mg/l.

b. Complete denitrification can recover 15% or more of the dissolved oxygen utilized for complete nitrification. In addition, denitrification can recover approximately one-half of the alkalinity utilized for nitrification.

c. A sufficient level of carbonaceous energy in the form of a biodegradable organic substrate must be provided to the anoxic reactor to achieve the design denitrification potential. The degree of nitrogen removal will be a function of the ratio or the carbonaceous energy level available, to the level of TKN oxidized to nitrate nitrogen. The minimum ratio of influent total (five-day) BOD to TKN appears to be approximately 10 or more to achieve effluent levels of 10 mg/l or less of total nitrogen.

d. Complete denitrification may require at least two anoxic stages with a total hydraulic retention time of one hour or more. The anoxic mass fraction should be based on the specific growth rate of the nitrifying/denitrifying microorganisms and the operating mean cell residence time. However, the anoxic mass fraction should be approximately 25% or more of the system biomass.

e. A flexible operating mean cell residence time should be provided around a typical value of 10 days depending on the wastewater temperature. The capacity to recycle flow of nitrified activated sludge to the anoxic reactor should exceed three times the average daily raw sewage flow.

D. Denitrification. If pilot plant data cannot be obtained for the specific wastewater involved, denitrification reactors should be sized through acceptable kinetic models. The average wastewater characteristics for both raw influent and primary (settled) effluent, if applicable, shall be established as follows:

a. Both the total and soluble BOD and COD and the biodegradable fractions of each parameter.

b. The nitrogen fractions; ammonia, TKN, NO3-N.

c. Total and soluble phosphorus.

d. The specific growth rate of nitrifying bacteria.

e. The design wastewater temperature and pH.

1. A supplemental organic substrate feed to a denitrifying reactor may be utilized to achieve denitrification if the influent and recycled flows from the mainstream process do not provide a sufficient amount of substrate. Methanol is commonly used because of lesser cost and lower sludge yield. Methanol requirements should be computed as follows:

Methanol requirements (mg/l) = (2.47) (Influent Nitrate-Nitrogen (mg/l)) + (1.53) (Influent Nitrite-Nitrogen (mg/l)) + (0.87) (Influent Dissolved Oxygen Concentration).

Chemical feed pumps shall be provided in duplicate. Alternate organic substrate sources may be considered with chemical dosages determined stoichiometrically.

2. The amount of methanol or other organic substrate source feed must be closely controlled because excessive feed would result in a residual BOD in the treatment works effluent. A means of automatically pacing the feed to the incoming nitrate concentration shall be provided. Flow pacing shall not be acceptable because of varying nitrate concentrations.

3. The denitrifying reactor shall be followed with an aerated stabilization tank with sufficient detention time to remove any excess oxygen demand resulting from organic substrate source addition and to polish the treatment works effluent.

4. Clarifiers should be designed with a maximum settling overflow rate of about 1,200 gallons per square foot per hourly day at peak flow. A surface skimming device with provisions for returning scum to the denitrification tank shall be provided. The design should be similar to that of secondary clarifiers as provided in this chapter.

5. Dual return pumps shall be provided, each with the capacity to return a minimum of 100% of average flow upstream of the denitrification reactors. Provisions shall be made to transport sludge from the settling basin to the nitrification system in the event that nitrifying sludge is unavoidably discharged into the denitrification system.

6. Denitrification design should address the following parameters:

a. Sludge yield. 0.15 to 0.25 pounds of cells per pound of methanol; 0.5 pounds of cells per pound of glucose, 0.1 pounds of cells per pound of COD (based on methanol).

b. Sludge age. Minimum sludge age to allow mitosis is one-half day at 20°C to 30°C and two days at 10°C. With a safety factor of seven, a design sludge age of 3.5 to 14 days should be considered for temperatures of 10°C to 30°C, using the wastewater temperature dictating the design values.

c. pH. Satisfactory performance can be obtained at pH values of 5.6 to 9.0. The optimum pH range is 6.5 to 7.5. Facilities for pH adjustment should precede the denitrification reactor if necessary.

d. Mixed liquor volatile suspended solids--1,200 to 2,000 mg/l.

e. Detention time--two to four hours.

7. Ponds utilized for denitrification shall be considered on an experimental basis only. Ponds must be covered to prevent wind mixing and photosynthetic oxygen production. Unsuccessful operation has been reported for temperatures below 14°C.

E. Selector systems. These processes are designed to provide a competitive advantage to maintain a desired group of microorganisms within the process. Systems of this type, which will be accepted on an experimental basis (unless sufficient operating data are made available), are as follows:

1. Activated sludge biomass may be subject to extended aeration conditions to accomplish carbonaceous organic oxidation (oxic) and nitrification without settling. Denitrification may be accomplished by introducing the nitrified effluent from the reactor (the mixed liquor) to established anoxic conditions. The anoxic effluent mixed liquor is settled in a clarifier from which return sludge is recycled to the aeration phase for BOD removal. In this process a supplementary organic carbon source is not used, as endogenous respiration of the mixed liquor suspended solids will satisfy the carbon requirement for biological metabolism.

2. Activated sludge reactors may be utilized in series, followed by a clarifier, with nitrified activated sludge biomass returned to a combination of selectors or anaerobic or anoxic conditions established in separate basins. The anaerobic and anoxic reactors should be mixed at a level sufficient to keep the solids in suspension.

a. Nitrification is achieved under aerobic or oxic conditions and mixed liquor from the aerated basin, or basins, is returned to the anoxic basin, or basins, at rates up to and exceeding three times the average flow rate of the influent.

b. Denitrification is obtained under anoxic conditions. The nitrate contained in the aerobic mixed liquor is reduced by the facultative anaerobic bacteria in the anoxic basins using the influent organic carbon compounds as hydrogen donors. Influent ammonia is not nitrified in the anoxic phase.

F. Attached growth systems. Flooded and submerged fixed film contact reactors or biomass support surfaces can be considered for nitrification and denitrification applications in accordance with the provisions of this chapter and standards contained in this chapter. Such designs shall be verified through submission and evaluation of satisfactory operating data. Possible alternatives include (i) the use of biomass support surfaces located within the downstream sections of suspended growth reactors to provide ammonia oxidation; or (ii) the use of contact reactors for nitrification and denitrification.

1. Packed bed contact reactors should be designed in a manner similar to gravity deep bed filters or pressure filters. Provisions shall be provided for backwashing the reactor. Media may consist of silica, activated carbon, volcanic cinders, and acceptable synthetic materials. The smaller media will result in the retention of bacterial floc in the filter, resulting in increased head, and shortcircuiting of flow may develop through the filter, unless frequent backwashing is provided. Larger media permits operation without frequent backwashing, although contact times are reduced, resulting in an increase in effluent suspended solids. High density media larger than 1/2 inches in effective size could produce backwashing problems and may require additional backwashing capability.

2. Nitrate reduction of greater than 90% can be achieved with fixed film contact times of one hour for one inch aggregate and two hours for two-inch aggregate at temperatures above 12°C. The actual detention time necessary for the chosen media shall be based on pilot studies and should be varied in accordance with the specific surface area of the media and temperatures expected. For well rounded sand of two to three mm diameter, the following guidelines for reactor sizing are suggested when pilot plant data cannot be obtained

Wastewater Temperature	Fixed Film Reactor Time (Based on Media Composed of Sand)
20°C	10 minutes
15°C	22 minutes
10°C	45 minutes
5°C	90 minutes

3. Provisions shall be made for feed of a biodegradable carbon source, if necessary, based on the guidelines specified for suspended growth reactors.

4. Additional clarification is not required following the packed bed filter, unless the permit specifies an effluent suspended solids concentration of five mg/l or less.

5. Limited experimental data are available for upflow contactors with fluidized media beds and any design must be supported by operating data obtained from existing installations or from a thorough pilot scale study, including requirements for chemical feed additions.

6. One-inch diameter stone media may be specified for upflow contactor media to allow upflow operation without exceeding the scouring flow rates that could result in backwashing or stripping of attached growth. The disadvantages of large media sizes include a reduction in contact time and increased effluent suspended solids as compared to smaller media such as sand. For one-inch diameter or less media, size should be specified to achieve nitrate nitrogen removals up to 90% with methanol feed at temperatures as low as 12°C. Provisions should be made to remedy any head loss build up during operation.

7. Actual upflow contact time should be provided in the range of one to four hours at flow rates of 0.2 to 0.4 gallons per minute per square foot respectively, for white silica sand media with an effective size of 0.6 mm and a uniformity coefficient of 1.5.

8. A source of carbon, if necessary, shall be applied to upflow contact reactor influent based on guidelines outlined for suspended growth reactors. Design should be based on minimum wastewater temperature and maximum influent nitrogen concentration. Provisions shall be made for conveying nitrogen gas from the system.

9. If the upflow contactor is operated properly, additional clarification should not be required, unless the permit or certificate issued specifies an effluent suspended solids level of 10 mg/l or less.

9 VAC 25-790-910. Biological nitrification.

A. Biological nitrification is a process whereby autotrophic nitrifying bacteria convert ammonia nitrogen to nitrate nitrogen. This process is capable of removing most of the nitrogenous oxygen demand from domestic wastewater but does not remove the nitrogen itself. Should nitrogen removal be required, denitrification facilities must follow nitrification facilities. Although the nitrification phenomenon has been observed for some time, unit process design for optimum nitrification performances has only recently been employed.

If adequate performance data are not available, pilot plant evaluation for a particular application shall be completed prior to a full scale design proposal for upgrade of existing facilities. The recommended minimum or maximum design capacities are provided as guidelines and should be used if actual performance data or pilot plant evaluations do not provide sufficient design information.

B. Single stage design. Single stage systems should be considered for cases where nitrification must be provided only during periods when wastewater temperatures are above 13°C (55°F). For cases where nitrification must be provided for prolonged periods of temperatures less than 13°C, two stage activated sludge, biological nutrient removal, or combinations with fixed film growth systems should be considered.

1. The reactor design shall prevent short-circuiting. Plug flow basins should be used, with consideration given to dividing the reactor into a series of compartments by installing dividers across the basin width with ports through the dividers.

2. The aeration capacity shall be sized for the peak ammonia load. Where data are not available on ammonia variation, a peak hourly ammonia load (lbs/day) of 2.5 times the average load (lbs/day) should be assumed. The aeration supply should have a capacity determined by the following formula where automated blower controls linked to D.O. probes are provided:

Aeration supply = 800 cu. ft. per total pounds of (BOD_5 +NOD)

where: NOD = 4.6 x total Kjeldahl nitrogen (TKN)

BOD_5 = 5 day BOD entering the aeration basin

The peak BOD_5 and NOD must be used to ensure around-the-clock nitrification. The above air quantity should be doubled if automated blower controls are not provided. The design should maintain a D.O. concentration greater than 1.0 mg/l.

3. Aeration basin detention time should be based upon pilot plant data on the specific wastewater involved. Proper control of industrial discharges must be provided to minimize the possibility of biological toxins upsetting the nitrification rates. The following minimum criteria are suggested for municipal wastewaters free of significant industrial wastes and which are subjected to primary settling prior to aeration.

a. Sludge age = 10 days or more and F/M = 0.25 or less

where: F/M = total daily lbs BOD_5 to aeration basin divided by average lbs active biomass in aeration tank.

b. Active biomass is measured by the volatile portion of the suspended solids concentration within the aeration basin (MLVSS).

4. Nitrification will destroy 7.2 lbs of alkalinity per pound of NH3-N oxidized. If the wastewater is deficient in alkalinity, alkaline feed and pH control must be provided. Sufficient alkalinity should be provided to leave a residual of 30-50 mg/l after complete nitrification.

5. The design of final clarifiers will be similar to secondary clarifiers serving suspended growth reactors. The basin shall be equipped with a surface skimming device. A minimum biomass return rate of 25% and a maximum of 100% of the average daily flow shall be provided.

C. Two-stage design. To assure year round nitrification, a two-stage system is considered necessary. Superior performance of the two-stage systems for both BOD and NOD removal is attributed to the selection of an optimum biomass. The BOD_5 entering the second stage should be 50 mg/l or less to prevent a washout of the nitrifying bacteria. Properly operated contactors or high rate activated sludge systems should provide acceptable first stage systems. The second stage activated sludge system should remove at least 50% of the remaining BOD_5 and provide oxidation of 85% to 100% of the ammonia nitrogen.

1. The aeration basin should be of the plug flow type with a minimum of three baffled chambers. The basin should be sized to handle the "design peak" ammonia load at the lowest expected operating temperature and optimum pH.

2. Available information indicates that the optimum pH for nitrification of wastewater ammonia will be in the range of 8.2 to 8.6. Limited research results have indicated that the nitrifying bacteria can acclimate to pH values less than 8.0. It is recommended that the following information be used for guidance until additional operational information is available concerning the effect of pH:

pH	Fraction of Optimum Nitrification Rate
8.4 - 8.6	1.00
8.2	0.98
8.0	0.95
7.8	0.88
7.6	0.80
7.4	0.68
7.2	0.58
7.0	0.48
6.8	0.38
6.6	0.30
6.4	0.24
6.2	0.18
6.0	0.13

Lime feed capability should be provided to maintain the pH in the aeration basin within optimum range. Quantities of lime needed should be based on (i) pH adjustment of incoming wastewater, (ii) destruction of natural alkalinity of 7.1 lb $CaCo_3$/lb NH3 oxidized, and (iii) maintaining residual alkalinity of 30-50 mg/l. When adequately buffered wastewaters are treated, it may be more economical to add additional tank capacity in lieu of operation at optimum pH.

3. Where performance data or pilot plant data are not available, the following nitrification rates may be employed in the design of the aeration basin. These rates are established for optimum pH. If the design is based on a pH range other than the optimum range, the nitrification rates should be reduced.

Temperature (°C)	Nitrification rate-lbs NH3 N nitrified/day/lb MLVSS
5°C	.04
10°C	.08
15°C	.13
20°C	.18
25°C	.24
30°C	.31

A MLVSS concentration of 1,500-2,000 mg/l is recommended.

4. Either diffused air or mechanical aeration may be used. The dissolved oxygen concentration in the aeration basin should be based on obtaining 3.0 mg/l during average conditions but should never fall below 1.0 mg/l during peak flow conditions.

a. The design of the aeration system should incorporate: (i) critical wastewater temperature, (ii) minimum dissolved oxygen concentration, (iii) wastewater oxygen uptake rate, (iv) wastewater dissolved oxygen saturation, (v) altitude elevation of the treatment works, (vi) aerator efficiency.

b. The stoichiometric oxygen requirement of the wastewater can be computed and expressed as daily pounds using the following formula: (O_2 required) = BOD_5 from 1st stage + 4.6 (TKN)

5. This oxygen requirement is somewhat conservative since neither all of the BOD or NOD will be completely satisfied. In order to balance the summer oxygen requirement, provisions for one or more of the following reactor adjustments shall be included:

a. Reduce the MLVSS concentration;

b. Adjust the pH; or

c. Reduce the volume in service and increase the oxygen supply in remaining volume.

6. Design information for optimum settling rates is limited. However, it is recommended that the final clarifier design be similar to secondary clarifiers when operating data or pilot plant information is not available. A sludge return capacity of 100% to 150% of the average flow is recommended. Continuous and intermittent sludge removal capability should be provided. The waste sludge quantities typically will be small in comparison to first stage activated sludge quantities and may be combined with first stage activated sludges for further processing.

D. Fixed film design. Various types of attached growth or fixed film unit operations have been studied to determine their ammonia removal capabilities. Conventional standard rate contactors can provide a significant amount of nitrification during warm months but, in general, do not provide consistent year round nitrification. As in the suspended growth systems, a separate fixed film unit operation for nitrification is also deemed necessary to maintain consistent year round performance. However, the use of fixed film biomass support surfaces within aeration basins have demonstrated effective nitrification. Biomass support surfaces would typically be located in the downstream end of aeration basins, occupying the last one-third of the basin length. One of the major advantages that fixed film nitrification seems to have over suspended growth nitrification appears to be stability. Contactor type reactors used for nitrification typically include synthetic media for enhancing the surface area to volume ratio, which generally exceeds 25 square feet of total surface area per cubic feet of media volume. These fixed film contactors generally may be classified into one of the following types based on media construction:

a. Column or tower (top loaded).

b. Submerged surface (plates or strands).

c. Rotating disc (partially submerged).

1. Numerous variations in features and arrangements of fixed film contactors have been investigated. Significant nitrification should occur through a fixed film reactor, provided that the biomass surface area is properly sized and uniformly loaded with respect to influent levels of soluble BOD and ammonia nitrogen. No specific design loading criteria or guidelines are proposed at this time. A hydraulic loading of one gpm or less per square foot of specific media surface has resulted in efficient nitrification of secondary effluent in previous studies. Results of such studies also indicate that the organic loading should be maintained at or below 10 pounds BOD_5 per day per 1,000 cubic foot of media surface. The results of pilot plant studies for specific applications should provide design loading values. Review of fixed film nitrification design will be approached on a case-by-case basis. Influent wastewater characteristics affecting nitrification performance include:

a. Soluble BOD.

b. Ammonia Nitrogen.

c. Temperature.

d. pH.

e. Alkalinity.

f. Toxicity (nitrifier inhibitors).

2. The values of nitrification performance are valid for wastewater temperatures greater than 16°C (60°F). At a given loading rate, ammonia removal efficiency decreases nonlinearly with decreasing wastewater temperature.

Loading Rate (gpm/square foot)	Nitrification Performance % Removal of Ammonia
.50	90
.75	85
1.00	80
1.50	75

9 VAC 25-790-920. Ammonia stripping.

Ammonia stripping is the chemical-physical process by which dissolved ammonias are converted to gaseous ammonia and removed from the wastewater by changes in the surface tension of the air-water interface. The removal of ammonia nitrogen in treated effluent is the objective of this treatment unit operation.

1. Ammonia stripping typically involves the addition of lime to treated effluent (secondary or advanced treatment), followed by agitation in the presence of air. Wastewater effluent with an adjusted pH of 10 or more is usually allowed to flow downward through special media. The ammonia gas which develops is stripped out by the passing contact with outside air. These ammonia stripping towers become inoperable at temperatures below freezing (32°F or 0°C wet bulb). Therefore, before consideration can be given to ammonia stripping the minimum air temperature must be determined and provisions made to prevent freezing.

2. For effective conversion of ammonium to ammonia gas the system pH must be maintained at a minimum of 10.5 on a continuous basis. The elevation of the pH of the wastewater for conversion of the ammonium to ammonia should be selected from the ammonia solubility curve versus pH.

Ammonia stripping units may be of countercurrent operation or utilize cross flow air movements. Minimization of scale formation may be obtained by countercurrent operation.

3. The loading applied to the stripping reactor should not exceed 1,250 pounds of wastewater ammonia per hour per square foot of cross-sectional media area. The gas-liquid ratio shall normally be in the range of two to four expressed in terms of pounds per square foot per hour of air, divided by pounds per square foot per hour of wastewater.

4. The reactor media shall be (i) resistant to continuous loading of high pH liquid; (ii) consist of material which can be readily cleaned of scale deposits; and (iii) structurally sound. Facilities shall be provided for media cleaning, consisting of either manual means, or high pressure jets of water, or other approved means. Provisions shall be made for treatment of washdown waters and scale removed from the packing media.

5. In areas where reliability is questionable due to physical restraints of the system, a back-up system for nitrogen removal shall be required. Duplicate pumping units are required where pumping is employed to apply or remove the liquid.

6. Facilities shall be provided for post-pH adjustment.

7. Considerations shall be given to remote locations for stripping reactors in relation to bodies of water. Each proposal shall include sufficient information to substantiate expected plume dispersion areas and, if necessary, removal of ammonia gas from the plume.

9 VAC 25-790-930. Ion exchange.

Ion exchange may be utilized as a unit operation in which ions are exchanged between two different materials, usually a solid-liquid, but may involve a liquid-liquid exchange. In wastewaters, the exchange usually involves a solid resin material consisting of readily ionized compounds. Treated effluent (secondary or advanced treatment) passes at a controlled rate through a certain volume of resin within a contactor. The removal of 90-95% of the ammonia nitrogen can be achieved by such treatment. Ion exchange may also be utilized for removing heavy metals, nitrates, phosphates, sulfides, phenol, and chlorophenols from wastewaters.

1. The process specifically designed for ammonia nitrogen removal uses a clinoptilolite resin. Many of the design considerations are applicable to other types of ion exchange treatment, including:

a. Flow, total dissolved solids, suspended solids, ion specific concentrations, alkalinity, pH, and resin structure.

b. The rate of exchange based upon selectivity of the resin, the exchange capacity of the resin, waste strength, and the effluent requirements.

c. The exchange capacity and break through point.

d. Certain contaminants which create treatment problems in the operation of ion exchange. Where these contaminants exist, their removal shall be provided for if necessary through the methods of pretreatment listed in Table 10.

TABLE 10.
METHODS OF PRETREATMENT.

Contaminant	Effect	Removal
Suspended Solids	Blinds or seals resin media with particles	Coagulation and filtration
Organics	Large molecules (e.g. humic acids) will foul strong base	Carbon absorption or use of weak base resins only resins (high pH)
Oxidants	Slowly oxidizes resins. Functional groups become liable (unstable)	Avoid prechlorination or neutralize the chlorine.
Iron, Manganese, and Dissolved Solids	Coats resin with charged particles.	Chemical clarification or aeration depending on nature of solids.

2. Clinoptilolite mineral should be crushed and screened resulting in particle sizes in the range of 20 X 50 mesh. Ion exchange capacities and selectivity shall be determined in pilot plant studies for the particular wastewater in question. The pH of the influent to the exchange resin contactor should be in the range of 4-8.

3. The following parameters shall be considered for design of the ion-exchange contactor:

a. Flow rates in the range of five to 15 resin volumes per hour are normal but the specific design loading shall be confirmed by pilot studies or performance data.

b. The contactors may be gravity or pressure type units.

c. A minimum of two units is required. The number of contactors required is governed by the length of cycle which can be achieved while still meeting effluent quality goals. This shall be determined by pilot tests on the specific wastewater involved.

d. The number of contactors shall be adequate to treat the maximum flow rate in compliance with appropriate permit or certificate requirements, with one contactor out of service for maintenance and an appropriate number out of service for regeneration.

e. Means must be provided to uniformly distribute the influent flow and regenerant flow over the entire area of the contactor.

f. Make-up clinoptilolite storage shall be provided, as well as a water slurry transfer system to move the clinoptilolite from storage to the contactor.

g. Facilities to wash the clinoptilolite prior to transfer to the contactor shall be provided. Means to transfer clinoptilolite from a contactor to the storage system for washing should also be provided.

h. The process shall be controlled by a control system which will automatically initiate and program the regeneration cycle and return the contactor to normal service.

i. Each contactor shall have a flow totalizer. Also, each contactor shall have a flow rate controller to maintain equal flows to all contactors.

j. Each contactor shall be equipped with an efficient surface wash device.

4. With a neutral regenerant, provisions shall be made for a contactor backwash supply with minimum capacity equivalent to 10 gpm/sq ft of contactor area. If wastewater temperatures exceed 25°C (72°F) for prolonged periods, a greater capacity may be required. If a high pH regenerant is used, a minimum backwash capacity of 15 gpm/sq ft should be provided.

5. Regeneration facilities shall be provided for the ion exchange resin. Regeneration may be by high pH regenerant or neutral pH regenerant. Supportive data from fully operational units or from a pilot plant shall be provided to demonstrate acceptability of the proposed regeneration method.

6. Treatment or recovery of regenerant shall be provided. The design should provide for removal of ammonia with recovery of the regenerant through either (i) electrolytic treatment at neutral pH, or (ii) air stripping, or (iii) steam stripping, at elevated pH. Supportive data from a fully operational unit or pilot plant shall be provided to demonstrate acceptability of electrolytic treatment at neutral pH and steam stripping at elevated pH.

PART IV.
REPORTS AND FORMS.

Article 1.
Reports.

9 VAC 25-790-940. Preliminary Engineering Report.

A. A letter of transmittal consisting of a one-page or more letter typed on the submitting firm's letterhead should be submitted with the Preliminary Engineering Report and should include the following items:

1. Confirmation of a submission of the report to the client;

2. Statement of feasibility of constructing the project; and

3. Identification of all applicable areawide studies project, drainage basin, service area or metropolitan area plans with which the project has been coordinated.

B. A title page shall be included at the beginning of the report and should contain the following information:

1. Title of project and project number;

2. Municipality, county, etc.;

3. Names of officials, managers, superintendents;

4. Name and address of firm preparing report;

5. Seal and signature of appropriate professional in charge of project.

6. Grant number of grant project; and

7. If an expansion, existing certificate or permit number.

C. A table of contents shall be included on the report and should include such listings as:

1. Section headings, chapter headings and subheadings;

2. Maps;

3. Graphs;

4. Illustrations, exhibits;

5. Diagrams; and

6. Appendices.

Number all pages; cross reference by page number.

D. A summary of the findings, conclusions, and recommendations shall be included in the report and should address the following information:

1. Findings. Summarize the findings for the client.

a. Population and design flows--present, design (when), ultimate.

b. Land use and zoning--portion contributed by residential, commercial, industrial, greenbelt, etc.

c. Sewage characteristics and concentrations-portions of total hydraulic, organic, and solids loading attributed to residential, commercial, and industrial fractions and description of sewage nondomestic in character.

d. Sewerage system projects--immediate needs to implement recommended project and deferred needs to complete recommended projects, including pump station, force mains, appurtenances, etc.

e. Selected process--characteristics of process and characteristics of output.

f. Receiving waters--existing water quality and quantity, classifications and downstream water users, and impact of project on receiving water.

g. Total proposed project costs considered for each alternative.

h. Changes--alert client to situations that could alter recommended project.

2. Conclusions. Describe the project as recommended to client for construction.

3. Recommendations. Summarize step-by-step actions, for client to follow to implement conclusions:

a. Official acceptance of report;

b. Adoption of recommended project;

c. Submission of report to regulatory agencies for review and approval;

d. Authorization of engineering services for approved project (construction plans, specifications, contract documents, etc.);

e. Legal services;

f. Enabling ordinances, resolutions, etc., required;

g. Adoption of sewer-use ordinance;

h. Adoption of operating rules and regulations; and

i. Time schedules--implementation, construction, completion dates, reflecting any applicable certificate or permit enforcement actions.

E. An introduction shall be included in the report and should describe the following:

1. Purpose. Reasons for report and circumstances leading up to report.

2. Scope. Coordination of recommended project with area-wide, project, drainage basin, service area or metropolitan area plan and guideline for developing the report.

3. Background: appropriate past history.

a. Existing area, expansion, annexation, intermunicipal service ultimate area.

b. Drainage basin, portion covered.

c. Population growth, trends, increase during design life of facility (graph).

d. Residential, commercial and industrial land use, zoning, population densities, industrial types and concentrations.

e. Topography, general geology and effect on project.

f. Meteorology, precipitation, runoff, flooding, etc., and effect on project.

g. Existing ordinances, rules and regulations, including defects and deficiencies, etc.

h. Recommended amendments, revisions, or cancellation and replacement of local ordinances.

i. Sewer-use ordinance (toxic, aggressive, volatile, etc., substances).

j. Surcharge based on volumes and concentration for industrial waste waters.

k. Existing contracts and agreements (intermunicipal, etc.).

l. Enforcement provision including inspection, sampling, detection, penalties, etc.

F. The report shall include investigative considerations, including an existing facilities evaluation that should address the following as appropriate:

1. Existing sewerage systems:

a. Inventory the existing sewers.

b. Indicate the separation or isolation from water supply wells.

c. Review the collection system capacities and adequacy to meet project needs (structural condition, hydraulic capacity).

d. Tabulate any necessary pipeline or manhole testing, including gauging and infiltration.

e. List any existing points of overflows and required maintenance, repairs and improvements.

f. Outline any necessary rehabilitation, including repair, replacement, and stormwater separation requirements.

g. Establish renovation priorities.

h. Present recommended annual program to renovate sewers.

i. Indicate required annual expenditure.

2. Existing site:

a. Area for expansion.

b. Characteristics of terrain (drainage control).

c. Subsurface conditions.

d. Isolation from habitation (buffer zones).

e. Isolation from water supply structures.

f. Enclosure of unit operations, odor control, noise control.

g. Flood protection.

3. Existing treatment works:

a. Capacities and adequacy of unit operations (tabulate).

b. Relationship or applicability, or both, to proposed project.

c. Age and condition.

d. Adaptability to different usages.

e. Structures to be retained, modified, or demolished.

4. Existing sewage characteristics:

a. Water consumption (from records) (total, unit, industrial).

b. Sewage flow pattern, peaks, total, design flow.

c. Physical, chemical, and biological characteristics, and concentrations.

d. Residential, commercial, industrial, infiltration fractions, considering organic solids, toxic, aggressive, etc., substances (tabulate each fraction separately and summarize).

5. Environmental impact of sewage on receiving waters:

a. Sewage and industrial discharges upstream.

b. Receiving water base flow, min. mean-seven consecutive day drought flow with 10-Year Return Frequency (7Q10).

c. Characteristics (concentrations) of receiving waters.

d. Downstream water uses including water supply, shellfish, recreation, agricultural, industrial, etc.

e. Tabulation of effects on receiving waters.

f. Correlation of treatment works performance versus receiving water requirements.

G. The report shall include a proposed facility evaluation that should address the following as appropriate:

1. Sewerage system.

a. Inventory of proposed additions.

b. Isolation from water supply wells, reservoirs, facilities, etc.

c. Area of service.

d. Unusual construction problems.

e. Utility interruption and traffic interference.

f. Restoration of pavements, lawns, etc.

2. Site requirements. Comparative advantages and disadvantages as to cost, hydraulic requirements, flood control, accessibility, enclosure of unit operations, odor control, landscaping, etc., and isolation with respect to potential nuisances and protection of water supply facilities.

3. Sewage characteristics.

a. Character of sewage necessary to ensure amenability to process selected.

b. Need to pretreat industrial wastewater before discharge to sewers.

c. Portion of residential, commercial, industrial wastewater fractions to comprise projected growth.

d. Impact of proposed discharge on receiving waters--reliability requirements.

e. Tabulation of treatment performance versus receiving water standards.

f. Listing of effluent limitations.

4. Project alternatives.

a. Describe and delineate (line diagrams) each alternative.

b. Preliminary design for cost estimates.

c. Estimates of project's cost (total) (dated, keyed to construction cost index, escalated, etc.).

d. Advantages and disadvantages of each alternative.

e. Individual differences, requirements, limitations.

f. Select preferred alternative.

g. Justify selection and present tabulated comparisons.

h. Characteristics of treatment process performance.

i. Operation and maintenance expenses.

j. Annual expense requirements (tabulation of annual operation, maintenance, personnel, debt obligation).

5. Selected alternative.

a. Construction schedule.

b. Adaptability to future needs.

c. Design flow, variances, and effects on process.

d. Process functions and system backup.

e. Sludge management options.

f. Method of processing of excess combined sewage.

g. Outfall requirements, dispersion, etc.

6. Legal, financing and other considerations.

a. Necessary enabling legislation, ordinances, rules, and regulation.

b. Statutory requirements and limitations.

c. Contractual considerations on intermunicipal cooperation.

d. Public information and education.

e. Effect of state and federal assistance.

f. Exhibit conformance with all applicable federal requirements.

H. The report shall include technical information and design criteria that should address the following as appropriate:

1. Sewerage system.

a. Design tabulations--flow, size, velocities, etc.

b. Regulator or overflow design.

c. Pump station calculations.

d. Special appurtenances.

e. Stream crossings.

f. System map (downstream capacity).

2. Treatment works.

a. Criteria selection and basis of design for principal conventional features and all nonconventional features of the treatment process.

b. Hydraulic and organic loadings, minimum, average, maximum, and effect.

c. Dimensions of unit operations features within treatment process.

d. Rates and velocities of flow through the treatment process.

e. Detention periods provided for unit operations.

f. Concentration values projected for influent and effluent flows.

g. Recycle flows and rates within total treatment process.

h. Chemical additive control methods.

i. Physical control methods for rates of flow, etc.

j. A separate tabulation for performance ratings and treatment efficiencies of unit operations relative to residual solid and liquid processing.

k. Sludge management method.

l. Process configuration, interconnecting piping, processing, flexibility, etc.

m. Hydraulic flow profile.

n. Residual solids or sludge processing, including dewatering.

o. Unit operations flow diagram with capacities, etc.

3. Laboratory.

a. Physical and chemical tests and frequency to control process.

b. Time for testing.

c. Space and equipment requirements.

d. Personnel requirements--number, type, qualifications, salaries, benefits (tabulate).

4. Operation and maintenance.

a. Routine and special maintenance duties.

b. Time requirements.

c. Tools, equipment, vehicles, safety, etc.

d. Personnel requirements--number, type, qualifications, salaries, benefits (tabulate).

e. Processes needing chemical addition.

f. Chemicals and feed equipment.

g. Pump stations or regulator or overflow inspection and repair.

h. Flow gauging.

i. Industrial sampling and surveillance.

j. Ordinance enforcement.

k. Equipment requirements.

l. Trouble-call investigation.

m. Industrial pretreatment permits.

I. Management systems shall be described in the report including the following information as appropriate:

1. Personnel--recommended operator classification.

2. Equipment.

3. Chemicals.

4. Utilities.

5. Outline unusual specifications, construction materials, and construction methods.

6. Maps, photographs, diagrams (report size).

9 VAC 25-790-950. Contents for an operation and maintenance manual.

A. General. This section contains suggested and required contents for an Operations and Maintenance Manual. Items followed by an asterisk (*) should be submitted for treatment works or sewerage systems with design flows greater than or equal to 1.0 mgd.

1. Title page. The manual shall have a cover page that gives the title of the manual, the date the manual was prepared in final form, and the names of the authors of the manual.

2. Table of contents. The manual shall contain a table of contents that lists chapters and provides sufficient subsections in each chapter to permit easy identification of topics.

3. Introduction. The manual shall contain an introduction that briefly describes the organization and purpose of the manual. The introduction shall emphasize that the manual is operational in scope and will be updated so that it is not a static compilation of facts.

4. Definitions and terminology. Terms such as "BOD_5" and "Suspended Solids" shall be defined in this section of the manual.

B. Permit requirements.

1. CTO. The manual shall give the number of the CTO for the particular treatment works or sewerage system. The permit requirements shall be listed and discussed. This discussion should include, but is not limited to the following:

a. The manner, nature, volume, and frequency of the discharge permitted.

b. Procedures for and frequency of any domestic or industrial waste monitoring. This may be referenced to the laboratory testing section, but should include a brief table of testing procedures and sampling frequencies.

c. Requirements for the operators concerned with particular treatment works or sewerage systems as outlined by the State Board for Certification of Operators of Water and Wastewater Works and these regulations.

d. Legal penalties under state and federal law applicable to the operator for improper operations, records, or reports.

e. Any additional conditions or special restrictions specified by the State Water Control Board (SWCB), Department of Environmental Quality (DEQ), or any other concerned regulatory agency.

f. Any changes in treatment works or sewerage system classification due to future upgrading or expansion that may have been included in the original construction plans.

g. Time period for which permit is valid (expiration date) and any required upgrading that may have to be accomplished by the time for renewal.

A copy of the certificate and permit issued shall be included in this section with proper reference made to the appropriate regulations of the SWCB and DEQ.

2. Spill reporting. This section shall include a discussion of the federal/state laws and the SWCB/DEQ regulations and policies requiring reporting of a bypass/spill condition. This discussion should include, but is not limited to, the following:

a. The owner's responsibilities and liabilities;

b. Penalties for violations;

c. Reporting procedures and requirements;

d. Telephone numbers for immediate reporting to regulatory agencies and potentially affected downstream users; and

e. Sample reporting forms and instructions for completing them.

C. Process descriptions.

1. A flow diagram of the treatment works or sewerage system that shows all important components of the system.

2. Main line, recirculated, effluent, and sludge flows, etc., and design average/peak values of such flows.

3. A clear and concise description of each system component and its purpose, function, and type of treatment.

4. The expected influent/effluent concentrations and design efficiencies for unit operations and the treatment process.

5. This section may be combined with the "Operation and Control" section.

D. Operation and control.

1. Unit operation process description. The manual shall provide a general operational description of each unit operation. The descriptions should be brief with appropriate references to more detailed discussions of the unit operations. The description should physically trace the sewage flow through the unit operation and contain information on design efficiency. Pipeline and control schematics, valve location diagrams and operation keys, hydraulic/organic loadings, etc., should be included. Supplementary photographs and/or schematic diagrams should be included.

2. Relationship to adjacent unit operations. The function of unit operations located upstream, downstream or off-line from other unit operations should be described as they relate to other unit operations in the treatment process being considered.

3. Classification and control. Classification of each unit operation as conventional, I/A, etc., shall be included. The manual shall list and discuss the specific operational information and control techniques available for each major unit operation in the treatment process. This section shall be closely correlated with the specific treatment works or sewerage system operation. Process control variables such as recirculation ratios, valve/gate positions, pump controls, chemical feed rates should be included.

4. Common operating problems. Each major unit operation within the treatment works or sewerage system shall be analyzed and potential common operating problems defined. Potential problems that are peculiar to the treatment works or sewerage system under consideration shall be discussed. General problems that are adequately described in other sources shall be listed and properly referenced. Control of operating problems shall address the specific treatment works or sewerage system operation.

5. Laboratory controls. The manual shall list the laboratory tests that furnish information to evaluate and control the performance of the unit operation under consideration. Minimum testing requirements may be included in the operations permit. Expected ranges for the results of these tests shall also be given.

6. Start-up. The manual shall outline the steps for start-up of the unit operation. Information shall be provided on the special monitoring and controlling of the unit operation where treatment objectives are to be met.

7. Specific treatment works or sewerage system operation. The manual shall discuss (i) the normal operation, or the designed conventional loading conditions, of each unit operation, and (ii) alternate operation for unusual conditions for each unit operation. Information provided in this section shall enable the operator to operate the treatment works or sewerage system when it is not in the "normal operation" mode and shall be checked by the designer. It shall include methods and procedures with which to return the treatment works or sewerage system to "normal operation" following the proposed range of alternate operation conditions that may be encountered. It shall also include procedures and a logical decision-making process outline for the modifications of the original design "normal operation" and establishment of alternative operation conditions.

8. Emergency operation and failsafe features. The manual shall list and discuss the emergency operating procedures for the normally expected range of emergencies and failsafe features, particularly flood events, for each sewage treatment unit operation.

9. Process chemicals. A list of process chemicals shall be provided indicating minimum quantities to keep on hand and methods and precautions for storage.

E. Personnel responsibilities.

1. Operational and managerial responsibility. The responsibilities of both the operational personnel and the management personnel shall be clearly defined.

2. Staffing requirements and qualifications. This section is to reflect the personnel qualifications/certification and numbers for the treatment works or sewerage system. This should be formulated considering recommendations from the design engineer and the concerned regulatory agencies. The staffing plans for administration, supervision, operation, and maintenance shall be included. Certain positions in the staffing pattern that require certification by the state law shall be indicated in this section. Attendance requirements and routine work schedules with general responsibilities shall be presented. A delineation of training needs for administration and operational personnel shall be outlined in this section.

F. Laboratory testing.

1. Purpose and discussion. This section of the manual should explain the role of the laboratory in process control in providing an operating record for the treatment works and in analyzing problems within a unit operation.

The tests to be performed should be listed or charted, or both as appropriate, for permit required tests, such as discharge monitoring reports and process control tests. Sampling locations, frequency, etc., and a brief description of the analytical test and purpose should also be given. The detailed discussion of how each type test can be used in controlling or monitoring a specific unit operation shall be given in the "Operation and Control" sections. This portion of the manual should be tailored according to the laboratory staff capabilities of the treatment works under consideration. The following information shall be provided in this chapter.

2. Sampling program. This section of the manual shall include:

a. Sampling methods.

(1) Specific methods for obtaining grab and composite samples.

(2) Locations of all sampling points.

(3) Sampling procedures, including where samples are to be collected, and any special techniques, such as how to make up a composite sample or how to operate automatic samplers if applicable.

(4) Preservation of samples prior to analytical measurements.

(5) Sampling equipment and safety precautions (requirements).

(6) Projected range of test results on influent and effluent samples.

b. Equipment and chemicals.

(1) Lists of necessary laboratory equipment and proper usage noting importance of quality control.

(2) List of laboratory chemicals with common names, chemical names and formulas.

(3) List of suppliers' names, quantities used and shelf lives.

(4) Discussion of laboratory inspection.*

c. Operator/laboratory references. All essential references should be provided for proper laboratory operation. The detailed procedures for performing each test do not have to be included but should be properly referenced to one or more of the laboratory references provided.

d. Interpretation of laboratory tests.

(1) Expected ranges of typical results shall be included with explanation of typical transient differences from typical values.

(2) Detailed discussion in "Operation and Control" chapters.

e. Laboratory records. A brief discussion of the purposes for laboratory records recommended for use by the treatment works should be included.

G. Records and reports.

1. Daily operating log. This section of the manual shall delineate the requirement that operator's worksheets and daily operating logs be maintained. A sample log shall be included in the appendix.

2. Operational parameters. The daily log should outline the routine operational parameters for each unit operation, which shall include the minimum operational control tests required. These shall be adequate to enable proper operation of the units.

3. General information. This section of the manual should explain the operating conditions that should be recorded daily, such as:

a. Unusual conditions (operational and maintenance).

b. Accidents to personnel.

c. Complaints (odor, etc.).

d. Power consumption.

e. Plant visitors.

f. Personnel on duty/call.

4. Laboratory records. An example record sheet shall be included in the appendix. Information on the laboratory record sheet should include the following:

a. All lab tests to be performed with provisions for listing test results and summaries.

b. Wastewater flow and surrounding weather conditions at the time of sampling.

c. Chemicals used.

d. Analyst's name or initials.

e. Laboratory worksheets.

5. Monthly report to state agencies and federal government. The records section of the manual shall explain the responsibilities of the operator to report data to the appropriate agency, the reporting deadlines and how the monthly reports apply to the permit requirements. Sample forms of the monthly operation report, discharge monitoring report, etc., shall be provided in the manual's appendix.

6. Industrial and septage contributors. An inventory of significant industrial waste contributors shall be maintained. All sewage handlers that deposit septage at the treatment works shall be identified with pertinent information recorded, such as name of hauling company, volume deposited, date deposited, and description of the source of the septage.

7. Annual report.

a. This section of the manual shall discuss annual reports and who should prepare the report.*

b. The annual report should include management data relative to cost of operation.

c. Operating data included in the annual report should include average daily flow and average influent and effluent BOD and suspended solids for each month.

d. The annual report should include a graph showing at least 10 years of record (if available); personnel data; and budget data. An example annual report format shall be included in the appendix as applicable.

8. Additional records. The manual shall include specific information where records are available for reference and shall include:*

a. As-built engineering drawings.

b. Copy of construction specifications.

c. Equipment suppliers' manuals.

d. Data cards on all serviceable equipment.

e. Construction photographs.

9. Operating costs and record keeping. The manual shall provide a suggested operating cost breakdown for the treatment works or sewerage system.*

A record system for monitoring the cost shall be recommended.*

10. A personnel records procedure should be recommended that would include training.*

11. A record of emergency conditions affecting the treatment works or sewerage system shall be maintained. A system for maintaining these records shall be recommended.*

H. Maintenance.

1. Equipment record system. The maintenance chapter of the manual shall recommend an equipment record system. The equipment record system shall contain information on each item of operating equipment, such as common name, process function, date of purchase, manufacturer, serial number, availability of spare parts and previous

maintenance. Sample equipment record forms and provision that the forms be made a supplemental index to the manual shall be included.

2. Equipment numbering system. A numbering system to identify each item of equipment requiring maintenance shall be provided for easy identification and to help ensure that all equipment receives proper attention.

3. Equipment catalog. A catalog system shall be prepared that lists equipment descriptions, locations and equipment numbers. The catalog shall contain the following data for all major items of equipment. The data shall include, but not be limited to, the following information:

a. Equipment name;

b. Vendor;

c. Model Number;

d. Serial Number;

e. Make or Type;

f. Pertinent mechanical/electrical data; and

g. Source of Supply.

4. Planning and scheduling. The manual shall make recommendations on planning and scheduling maintenance tasks. Documentation showing the lubrication and other preventive maintenance task schedules shall be provided. The manual shall recommend that maintenance records be kept so that a preventive maintenance schedule can be established. The maintenance records shall provide for inclusion of maintenance problems and curative procedures. A work order system could be established to initiate all corrective maintenance tasks.

5. Storeroom and inventory system. The manual shall make recommendations for establishing a storeroom and inventory system. The manual shall contain the spare parts inventory established in accordance with these regulations. The inventory shall list the minimum and maximum quantities of the spare parts, the equipment in which they are used, their storage location, replacement procedures and schedules, reference to addresses of suppliers, and other pertinent information.

6. Costs and budgets for maintenance operations. The section shall provide guidelines for the determination of maintenance cost and the development of maintenance budgets.

7. Housekeeping. The manual shall recommend housekeeping activities to be performed.

8. Special tools and equipment. The manual should provide recommendations or appropriate references on tool room procedures, the use of tool boards and maintenance required for all special tools, where appropriate.

9. Lubrication. The lubrication section of the manual shall appropriately reference each equipment's lubrication specification. An alternate lubricants chart shall be provided in this section. The information required by the above section should be assembled into a lubrication guidebook and be included as an appendix to the manual.

10. Electrical equipment information. The manual shall list each major item of electrical equipment not listed in the equipment catalog.

11. Warranty provision. The manual should provide a listing of all equipment warranties and pertinent features of each replacement guarantee. Copies of the warranties shall be included in the manual's appendix.

12. Service contracts. The manual shall include a listing of all prearranged outside contracts for service and repair work.

13. Equipment reference handbook list. A list of equipment handbooks for reference should be included.

I. Emergency operation and response program.

1. Objectives. The objectives of an Emergency Operating and Response Program include:

a. Eliminating or minimizing adverse effects from emergency situations affecting the treatment works or sewerage system and/or employee welfare.

b. Developing procedures for properly responding to emergencies.

c. Providing instruction for personnel.

d. Providing inventories of available emergency equipment and outlining existing mutual aid agreements and contracts with outside organizations for specialized assistance.

2. Vulnerability analysis*. A vulnerability analysis shall be conducted and reported in the manual. A vulnerability analysis is an estimation of the degree to which the treatment works or sewerage system is adversely affected, in relation to the function it must perform by an emergency condition. Expected natural disasters such as flooding must be investigated and the effects of these disasters must be studied in order to estimate the treatment works' or sewerage system's performance.

3. Methods to reduce vulnerability. Priorities for repair of the treatment works or sewerage system and alternate equipment provisions in case of light or severe damage are to be indicated. To reduce vulnerability, training procedures for emergencies for regular and auxiliary personnel should be included.

4. Emergency equipment inventory. The manual shall require that, using the spare parts inventory and the results of the vulnerability analysis, any additional equipment and supplies needed for emergencies be stockpiled or be available through mutual aid agreements or contracts. These arrangements must be delineated.

5. Preserving system records. The manual shall contain procedures for keeping documents containing pertinent information about the treatment works or sewerage system safe from potential disasters.

6. Auxiliary personnel requirements. Procedures for obtaining trained auxiliary personnel in cases of emergency shall be included in the manual. Procedures for alerting these personnel should be outlined and periodically updated.

7. Emergency equipment testing. A schedule for testing of back-up systems such as standby power should be included.

J. Safety.

1. Requirements. The manual shall inform personnel of the known hazards, preventive measures, and emergency procedures applicable to, but not limited to, the following safety items:

a. Electrical hazards;

b. Mechanical equipment hazards;

c. Explosion and fire hazards;

d. Biohazards, i.e., bacterial type infection;

e. Chlorine hazards;

f. Oxygen deficiency and toxic gases;

g. Laboratory hazards;

h. Safety equipment; and

i. Process chemical handling and storage.

2. Safety references. The manual shall contain a list of safety references of interest to operating personnel. The manual shall provide a list of all emergency telephone numbers. The manual should provide a discussion of the importance of good housekeeping practices in relation to safety, a list of available safety equipment for process units, a list of number and location of first aid kits and manuals, a list of safety rules for process and laboratory equipment, and a key to system piping paint color coding.

K. Utilities*.

1. Requirements. This section shall list the utilities being used, the sizes and capacities of the lines serving the treatment works or sewerage system, emergency cutoff procedures, and the personnel to contact within each utility company to ensure proper response to routine and emergency situations.

2. Electrical. This section shall contain a brief statement on the reliability of electrical service. This statement should be based on studies of past performance and discussions with utility personnel. The discussion should include clearly defined breakpoints in responsibility for service facilities between the utility company and the treatment works or sewerage system owner.

3. Telephone. The telephone system, if used as an alarm system, should be described and a statement made as to "failsafe" capabilities.

4. Natural gas. The natural gas utility company should be named and a description of the service given. A statement of reliability should be made.

5. Water. The water system should be described, and a statement of reliability should be made.

6. Fuel oil. The manual should list the sources for fuel, the capacities of storage facilities and procedures for ensuring adequate supplies year round.

L. Appendices.

1. Requirements. This section of the manual shall include any additional or supplemental material not suitable for inclusion in the text. As stated in 9 VAC 25-790-950 A, items followed by an asterisk (*) are required only for treatment works or sewerage systems with design flows greater than or equal to 1.0 mgd. The appendix shall begin with an index.

The following do not have to be duplicated in the appendices if included elsewhere in the manual.

a. VPDES permit. A copy of any applicable permit shall be included here if not already included elsewhere in the manual.

b. Example forms. An example of all forms, including state and federal reporting forms, laboratory record forms, etc., to be used shall be included. Instructions for completing each form shall be given.

c. Equipment record example. The equipment record example with location and responsible personnel shall be included.

d. Personnel. Names, addresses and telephone numbers of personnel should be included.

2. Schematics. Any basic flow diagrams, process flow sheets, bypass piping diagrams and hydraulic profiles that are not included in the engineering drawings or manual text shall be placed in an appendix.

3. Valve Indices.* Valve indices shall be included in an appendix. Valve indices shall be one, or a combination, of the following:

a. A complete tabulation of principal valves, each separately numbered and identified as to type, location, and function.

b. A coding system for each type of valve, together with a prefix or suffix identifying its liquid content or process function, and location of each valve coded on the construction drawings.

c. Diagrams for principal valves, clusters of valves, and adjacent piping that are buried.

d. Location through at least two measurements to nearby permanent above-ground objects.

4. Any chemicals used and suppliers shall be listed.

a. Storage considerations shall be discussed.

b. Capacities of dry chemical storage areas and liquid storage tanks shall be described.

5. A list of the lab chemicals by common name, chemical name and the chemical formula shall be provided. Suppliers' names, quantities normally needed, and shelf life of each shall be given. Storage considerations shall be discussed.

6. An appendix shall give the design criteria for all unit operations and processes.*

7. The manual furnished with each piece of equipment shall be bound separately, and the index for these shall be included in an appendix.

8. A list of potential sources for the types of repairs and equipment parts required shall be made and listed in appendix.*

9. A complete and accurate set of as-built engineering drawings with included shop drawings shall be furnished immediately following testing and start-up.*

10. A complete set of engineering drawings shall be furnished sufficiently in advance of start-up to permit proper training of operating and maintenance personnel.*

11. Construction photos shall be taken throughout the construction phase and shall be included or indexed in an appendix. All pictures shall be labeled and dated.*

12. Copies of warranties and performance bonds shall be placed in an appendix.*

13. If there is an existing infiltration ordinance, a copy shall be included.*

14. If there is an existing industrial waste ordinance, a copy shall be included in an appendix.*

15. The coding system selected for use shall be outlined.*

16. The various types of coatings to be used are to be listed with a suggested painting schedule. The manufacturer's trade name and coating number and color shall be specified.*

17. A list of essential references recommended for immediate procurement and a second list giving references that may be obtained at a later date for use in operation and maintenance shall be provided.*

18. The Lubrication Guidebook shall be included.*

9 VAC 25-790-960. Influent and effluent sampling.

A. Sampling tests and frequency. Table C lists the typical recommended minimum sampling program schedules for all sewage treatment works (STW).

B. STW effluent tests and frequency of effluent testing and frequency of other sampling for a treatment works will be provided in the VPDES permit or the VPA permit.

TABLE C.
TYPICAL SAMPLING PROGRAMS FOR SEWAGE TREATMENT WORKS.

PLANT SIZE	>2.01 MGD	1.0-2.0 MGD	0.101-0.999 MGD	0.401-0.1 MGD	0.0011-0.04 MGD
Flow	Totalizing, Indicating & Recording	Totalizing, Indicating & Recording	Totalizing, Indicating & Recording	Totalizing, Indicating & Recording	Estimate
BOD_5, TSS, TKN	24- HC 1/ Day	24- HC 5 Days/ Wk	8-HC 3 Days/ Wk	4-HC 1 Day/ Wk	Grab 1/month
Total Nitrogen* Total Phosphorus*	24- HC 1/ Week	24- HC 1/ Week	8-HC 1/ 2 Weeks	4-HC 1/ Month	Grab 1/month
TRC, Contact tank**	Grab 1/2 Hr	4/Day at 4 Hr.Intervals	3/Day at 4 Hr.Intervals	3/Day at 4 Hr.Intervals	Grab 1/Day
Fecal Coliform**	Grab 1/Day 10am-4pm	Grab 5 Days/Wk 10am-4pm	Grab 3 Days/Wk 10am-4pm	Grab 1/Week 10am-4pm	Grab 1/Month 10am-4pm
pH, DO, TRC Effluent	Grab 1/Day	Grab 1/Day	Grab 1/Day	Grab 1/Day	Grab 1/Day
WQS Parameters (Toxics)	1/8,24 HC or 1/month	1/8,24 HC or 1/month	1/8, 8HC or 1/month	1/8, 4HC or 1/month	Grab 1/month

9 VAC 25-790-970. Operational testing and control.

A. Minimum tests and frequency. Table D-l contains the typical minimum sampling and testing program for operational control of treatment works greater than 40,000 gallons per day.

B. Sampling instructions. The following sampling instructions should be followed when taking samples:

1. When samples are taken for BOD_5, COD, volatile suspended solids, and suspended solids on influent and effluent streams, they should be composite samples.

2. All other samples should be grab samples.

TABLE D-1.
RECOMMENDED OPERATIONAL AND CONTROL TESTING.

Unit Process Parameters		Testing Location/Frequencies (see key for description)
1.	Primary a) DOB_5/TSS/TVS b) settleable solids c) pH	 1/bw; 2,3/2 2, 3/d 2,3,8/d

2.	Suspended Growth Reactor a) BOD_5/nutrients b) TSS/TVSS c) 30 minute SSV/pH/DO d) microscopic exam.	 1/bw; 2/w; 3/bw 6/d; 13/w 6/d 6/w
3.	Attached Growth Reactors a) BOD_5/nutrients b) TSS/TVS/microscopic exam. c) pH, DO	 1/bw; 2/w; 3/bw 14/w 1/d; 2/w
4.	Ponds of Lagoons a) BOD_5/nutrients b) TSS/microscopic exam. c) pH/DO/temperature	 1/w; 2/w 1/w; 2/w; 7/w 1/d; 7/d
5.	Anaerobic Digestion a) TS/TVS b) pH/alkalinity/temp.	 6,11,12/w; 8,9,10,13/bw 6,12/d; 11,15/bw; 6/w; 13/bw
6.	Aerobic Digestion a) TS/TVS b) settleable solids c) pH/temperature d) microscopic exam.	 6,11,12/w; 13/bw 6/d 6/d; 15/bw 6/w; 13/bw
7.	Sludge Thickening a) TS/TVS b) settleable solids	 1,2/d 6/d
8.	Sludge Dewatering a) TS/TVS b) pH/alkalinity	 1,2,4,12/q 15/q
9.	Chemical Clarification a) BOD_5/COD/TSS/TYS pH/alkalinity b) settleable solids/flocculation c) nutrients	 1,2/w 1,2,3,4,6/d 1,2,6/d 1,2/q
10.	Tertiary Filtration a) BOD_5/TSS b) pH/alkalinity c) nutrients	 1,2/w 1,2/d 1,2/q

TABLE D-1 - KEY

FREQUENCY

d - Daily

w - Weekly

bw - Biweekly

q - Daily when in operation

CONVENTIONAL PARAMETERS

BOD_5 - 5-day biochemical oxygen demand

SS - Suspended solids

TS - Total solids

VS - Volatile solids

DO - Dissolved oxygen

NUTRIENTS - Forms of phosphorus and nitrogen as required by the certificate CTO issued.

SAMPLING LOCATION

1. Process Influent
2. Process Effluents
3. Influent plus Return Waste Streams
4. Following Chemical Addition
5. Filtered Effluent
6. Contents of Reactor
7. All Cells of Each Lagoon or Pond
8. Raw Sludge
9. Primary Sludge
10. Secondary Sludge
11. Digester Influent
12. Treated Sludge
13. Return Sludge
14. Attached Growth

15. Process Supernatant

9 VAC 25-790-980. Factors for oxygen transfer.

A. Design. The oxygen supply requirements for diffused aeration systems serving suspended growth biological reactors should be established from the Alpha factor and the Beta factor (9 VAC 25-790-690 E 6).

B. Alpha factor. The alpha factor was once considered to be related only to wastewater characteristics, primarily surfactants. Additional investigations have shown that the alpha factor varies with other process conditions including mixing intensity, suspended solids concentration, and other factors, particularly the method of aeration. The alpha factor is unique for a particular wastewater treatment facility but is difficult to accurately determine; however, standards of practice for measuring the alpha factor have been proposed.

Reported observations on the variations of the alpha factor with diffuser type are as follows:

Bubble Size	Range of Alpha
Fine	0.4 - 0.55
Medium	0.7 - 0.8
Coarse	0.8 - 0.9

Other studies have similarly indicated lower alpha factors for fine bubble diffusers in comparison to coarse bubble diffusers. Summaries of reported values for alpha factors for mechanical aerators indicate a general range of 0.8 to greater than 1.0 with some values as low as 0.6. Increasing mixing intensity tends to increase the alpha factor.

C. Beta factor. The beta factor has been observed to vary over a moderate range, although the variations are generally less than observed variations of the alpha factor. One method proposed for estimating the beta factor uses the TDS concentration of the wastewater and the Standard Methods chart for saturation dissolved oxygen concentrations at various chloride levels in which

Beta Factor = C_{STC}/C_{ST},

where

C_{STC} - saturation dissolved oxygen concentration at

temperature, T and chloride concentration, C

(Substitute chloride conc. for TDS conc. when using chart)

and

C_{ST} = saturation dissolved oxygen concentration at

temperature, T and chloride concentration of 0.

Values reported for the beta factor for domestic wastewater are generally about 0.95 but considerable deviations from this value have been observed for industrial wastewater.

Article 2.
Forms and Agreements.

9 VAC 25-790-990. Portable equipment for sewage pump stations.

A. Compliance information. The following information is being provided to demonstrate to the department that the owner* will remain in compliance, after the addition of the proposed pumping station indicated below:

1. Name and location of proposed pump station;

2. Owner of proposed pump station (when placed into operation);

3. Number of pumping stations in owner's sewerage system using portable equipment for continuous operability (existing, approved, plus proposed in this project);

4. Number of portable pumps/generators required:**

a. Maximum number of stations on radial extremity:

b. Five percent of total number of stations (subdivision A 3 of this section):

5. Number of portable pumps or generators*** owned by owner:

Note: *When the proposed pump station will be transferred to city ownership and operation, then this analysis will be made for the city-wide system. If the pump station is to remain under a private owner's control, then the analysis will be performed for that owner's system only.

**The number of portable pumps/generators required is the larger number of either A 4 a or A 4 b of this form.

***Portable equipment, either singly or in combination, shall be capable of operating the largest pump station included in the total for A 3 of this form.

B. Compliance agreement. This agreement certifies that:

1. At the design peak flow the overflow time* is. The owner certifies that his standard response time** as detailed in his current service area response plan for a station at the proposed location is shorter than the overflow time noted above.

2. This station and associated portable equipment will be maintained and operated in accordance with the owner's approved operation and maintenance program.

Name

Title

Date

Note: *Time transpiring between high liquid level alarm and the time that an overflow or backup and subsequent discharge occurs (to be determined at peak design flow).

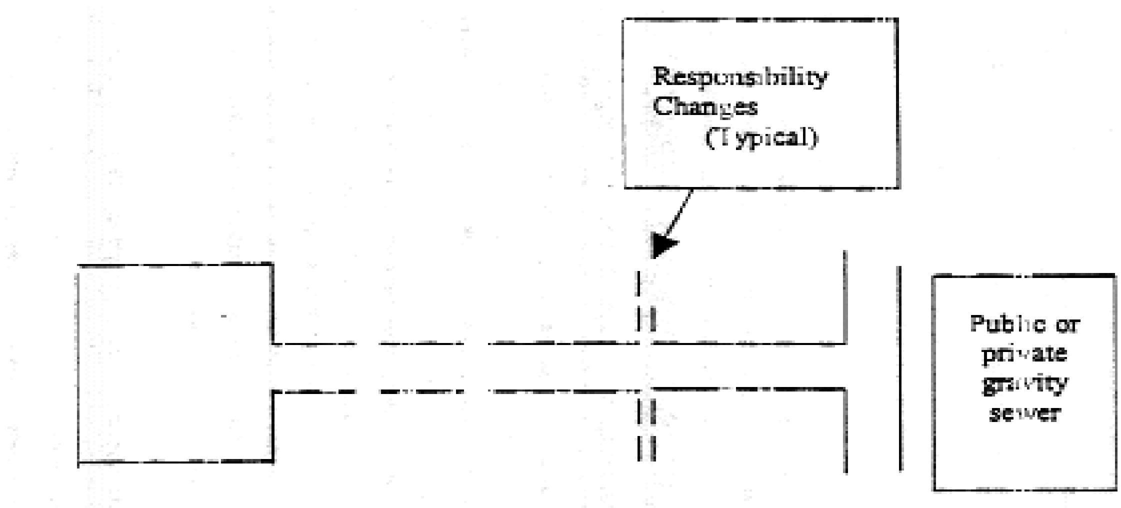
**Time transpiring between high liquid level alarm and connection and starting of portable equipment.

9 VAC 25-790-1000. General jurisdictional responsibilities for sewerage systems connections.

The following diagrams illustrate variations in sewer service connections and indicate the regulation jurisdiction (Uniform Statewide Building Code, Sewage Handling and Disposal Regulations, and the Sewage Collection and Treatment Regulations) for review and approval for construction and operation:

A. Gravity sewer:

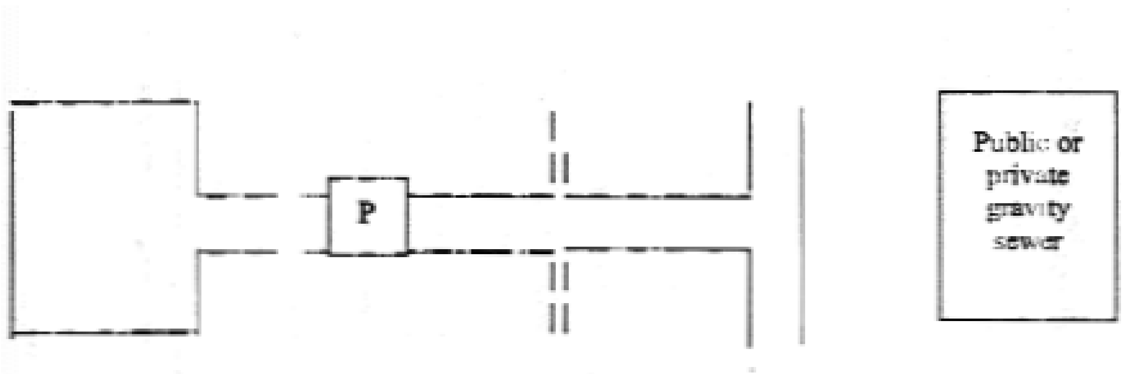
1. Building with flow by gravity:



2. Jurisdiction: Uniform Statewide Building Code (Code).

B. Pump within building:

1. Building with Pumped flow:

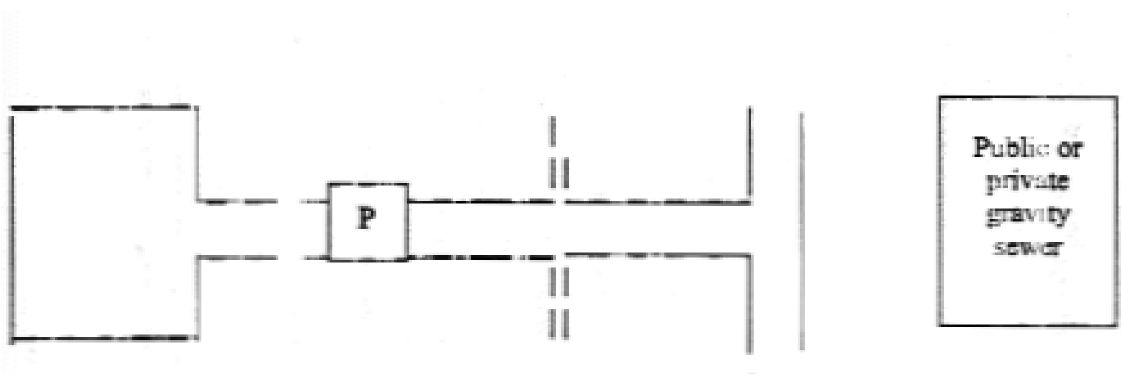


P--Pump within the building served.

2. Jurisdiction: Code when pumped flow is less than 2000 GPD. Sewage Collection and Treatment Regulations when pumped flow is equal or greater than 2000 GPD.

C. Pump remote from building

1. Building with remote pumped flow

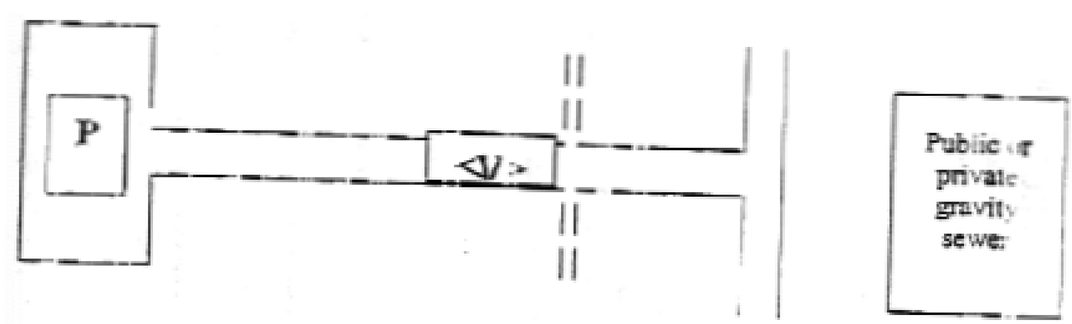


P--Pump separate from the building served.

2. Jurisdiction: Sewage Collection and Treatment Regulations when pumped flow is equal to or greater than 2000 GPD. Code when pumped flow is less than 2000 GPD.

D. Central pressure or vacuum system

1. Building with pump or remote vacuum valve.



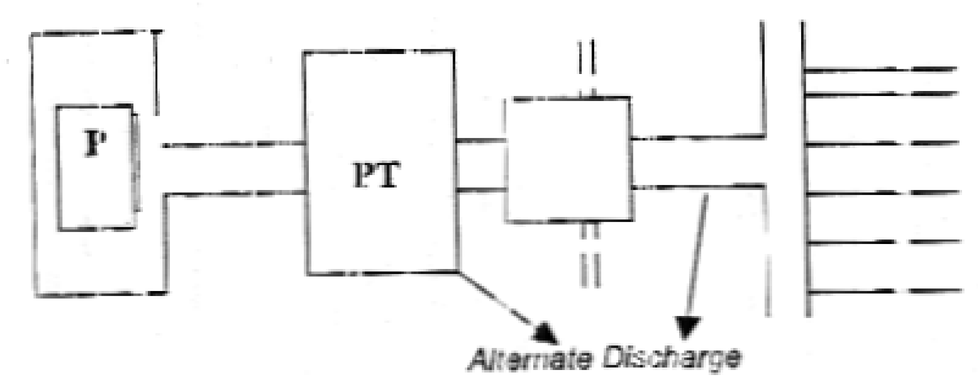
*P--Pump may or may not be provided.

<V>--Shows vacuum valve in service connection.

2. Jurisdiction: Sewage Collection and Treatment Regulations.

E. Gravity or pumped flow to an on-site disposal system.

1. Building served by on-site pretreatment units and drainfield (may or may not be provided) or other subsurface disposal.



P*--Pump that may or may not be provided.

PT*--Pretreatment may be provided.

2. Jurisdiction: Code applies to building service connection and pump if provided. Sewage Handling and Disposal Regulations applies to building sewer and on-site disposal system (alternative discharging systems subject to separate regulations).

J.2 The following notes explain symbols used in the diagrams:

i. ____ ____ Building drain (up to 5 feet beyond foundation of building or structure)

ii. | P | Sewage pump (grinder or nonclogging type)

iii. ________ Building sewer or force main

iv. <v> Vacuum valve for vacuum system

v. | PT | Pretreatment units including septic tanks, aerobic package plants, constructed wetlands, etc.

<u>DOCUMENTS INCORPORATED BY REFERENCE</u>

American Society of Civil Engineers (ASCE) Manuals and Reports on Engineering Practice--No. 36, 1974, American Society of Civil Engineers and the Water Pollution Control Federation.

Water Pollution Control Federation (WEF) Manual of Practice No. 9, 1970, Design and Construction of Sanitary and Storm Sewers, Water Pollution Control Federation.

AWWA Standard for Installation of Ductile-Iron Water Mains and Their Appurtenances, ANSI/AWWA C600-82, American Water Works Association.

Road and Bridge Specifications, July 1974, Virginia Department of Transportation.